THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XII., No. 3. 1886. Whole No. 38.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MAY 12, 1886.

CAPTAIN N. H. FARQUHAR, U. S. N., in the Chair.

PRIZE ESSAY FOR 1886.

Scire quod nescias.

WHAT CHANGES IN ORGANIZATION AND DRILL ARE NECESSARY TO SAIL AND FIGHT EFFECTIVELY OUR WAR SHIPS OF LATEST TYPE?

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I.—INTRODUCTION.

The Naval Institute may be congratulated upon the strictly practical and professional nature of the subject now presented for discussion. Questions of policy or expenditure heretofore discussed may be left to be acted upon or ignored by Congress or the Cabinet. The work of naval officers cannot be extended or our shipping increased, except through the slow and uncertain action of public opinion as expressed in the press or in our national legislature. The question now before us is, however, one which only naval officers can discuss, and it is one which they cannot afford to ignore.

The frank statement of the question recognizes a fact of vital importance and supplies us with a fundamental proposition. Changes are necessary, both in organization and drill, if our ships are to be made effective men-of-war. There may be those who would denounce any proposition to sail our ships effectively in time of peace as unseamanlike, and any discussion of methods for fighting in time of war as theoretical. In spite of these damnatory adjectives, we must

undertake the treatment of this difficult but inspiriting subject, which appeals to the interest of every officer who believes in the future of our naval service or expects to share in the arduous work of sailing and fighting ships of modern type.

When we come to consider our vessels of modern type with a view to suggesting changes in drill and organization, we find that they are few in number, of moderate tonnage, and neither armed with the most formidable weapons now in use nor protected by armor. Their motive machinery has not escaped criticism, and their construction by contract has been attended with delays and difficulties. These facts must be noted without discussion, and we must proceed to ascertain and develop the capabilities of the ships now in progress.

The Chicago and Atlanta types are intelligent attempts to solve the problems of actual naval warfare. Within the limits of their size and cost they may be classed as fast and well-armed ships. The attempt has been made, for the first time since the Civil War, to give us ships that can fight under way. The ships are intended to have speed and handiness, and their batteries have been selected and disposed with a view to enable them to choose their distance and to fight without surrendering all the advantages of speed and manœuvring power. Vessels loaded with smooth-bore guns which can only be fired abeam, and hampered by unnecessary spars and rigging, can neither fight nor run away in action. A proper disposition of the battery and the complete subordination of sails to steam will enable our new cruisers to make a choice between these courses.

The successive Advisory Boards deserve the thanks of the service for their efforts to put an end to the period of reaction and paralysis which has lasted ever since the achievements of the Navy during the Civil War. Their designs are distinctly progressive, and a quarter of a century in advance of those of the last group of ships authorized by Congress. Ten years ago our constructors were allowed to copy the general plans of cruisers built before 1860 without effective protest from the service or criticism from the press. A slight gain in economy of coal was the only result of fifteen years of mechanical improvement. The partial success of the new cruisers will render such fatal errors impossible in future. Steam is accepted as the vital force for cruising as well as fighting.

These designs show evidence of a thorough study of the best foreign examples extant three years ago. Delays have enabled foreign builders to make a further advance and to reach higher speeds

than are claimed for the vessels built by those contracts made under the direction of the Advisory Board. The lapse of time and the activity of naval improvement are sufficient to account for this. But the attempt to make use of examples from abroad implies a definite amount of progress in the sentiments of the service.

The vague, pseudo-millennial anticipations of some naval officers and politicians can no longer secure recognition. Nations will not turn their Krupps into smooth-bores, their torpedo boats into pleasure yachts, and forget what they know about war, simply because we are content to put up with less than our money's worth and maintain our Navy on an inefficient basis. Moreover, we must remember that our next war will certainly be a foreign war, and that it will bring us into collision with an actual naval power. We ought to welcome the assurance that our foes will not be of our own household, and we ought not to dread the possibility of a conflict with a warlike and maritime nation. It would seem as though another civil war, or one of those wretched little wars peculiar to colonizing nations, were the only contingencies for which we attempt to be prepared.

The new cruisers and their successors for which plans are now in preparation are fortunate in the discussion which their construction has stimulated. It will prevent that neglect of practical detail which too often characterizes meritorious designs. It should also do away with the tendency to rely upon miraculous inventions to solve all our difficulties, which seems to be one of our national peculiarities. In most of the arts it may be said that the age of the inventor has been succeeded by that of the designer. Certainly all recent progress in the instruments and appliances of naval warfare confirms this opinion. The results of experiment and the principles of science must be put into practical shape by the capable designer. New inventions may be incorporated, but designs of ships of war must be established on careful study of the latest facts.

Besides the special naval types under discussion, we must include others in any scheme of naval organization. Our traditional naval policy will always compel us to rely upon the mercantile marine for material to put our Navy on a war-footing. This fact suggests the incorporation of a few selected steamers of the latest mercantile type in our cruising squadrons. Officers should be trained to handle such vessels, and modern armaments should be experimentally adapted for their use. If proper care were used in selecting the best types of ships built from year to year, the Government might obtain many

improved features in machinery and equipment, with opportunities for testing them with a view to their use in regularly constructed men-of-war. Steamers of 2000 tons register could carry two large torpedo boats, each with a full outfit, besides a light armament, and a large cargo of stores and coal for use on long voyages, or for issue to other vessels. Well-built and full-powered steamers of this class could be purchased for less than it often costs to repair an obsolete and inefficient wooden corvette, and they would perform the ordinary cruising duties of a man-of-war in time of peace more creditably and economically than any vessel designed twenty years ago. Such vessels must be studied and recognized as types of auxiliary or torpedo cruisers for use in time of war. It is hardly necessary to recall the vast recent experiments in this direction carried on by the British Navy. Our present deficiencies emphasize the importance of this example. Not more than six such steamers would be required, and they should be sold as soon as they ceased to represent modern types. Such sales would not involve serious loss, if made within five or ten years after the vessels were built.

The attempt to discuss any question of burning importance to the naval service may involve the use of expressions which are lacking in respect for some venerable traditions and respectable prejudices. The form of the question is such that the answer will be nothing if not critical or comparative in its methods. Moreover, it is difficult to seek brevity and clearness without appearing to indulge in uncalled-for emphasis and assertion. If facts and details could be omitted and the exposition of fundamental principles substituted therefor, some of these dangers might be avoided.

This essay contains the present opinions of the writer, stated with as much frankness and clearness as he can command. He does not bind himself not to modify these opinions, nor does he predict their general acceptance and application in practice. The paper cannot come before its limited public without a signature, which must relieve the author from any imputation of posing as one having authority. It is hoped that these suggestions may be so clearly expressed and so kindly received that they will not be misunderstood by those who read them, or misinterpreted by those who do not care to take that trouble.

II.—Complement and Organization.

Some notice of the rules which should govern the allowance of officers and seamen to make up the complements of ships of modern

type must precede the discussion of plans of organization. The inevitable tendency towards replacing sails by steam might seem to promise a reduction in the number of men carried. Considering simple navigation as the work of a man-of-war, it might be practicable to follow the example of the mercantile marine in diminishing the proportion of crews to tonnage. Considering a ship as a military unit, we shall find that every improvement raises her fighting power and individual importance. The development of torpedo warfare and small-arm and machine-gun fire supplies employment for more men in action, besides multiplying occasions for detaching them for service on shore or in torpedo boats and steam launches. Ships cannot afford to deprive themselves of all power of manœuvring and defending themselves by detaching too large a proportion of their crews for military purposes, nor can they afford to miss occasions of rendering valuable service in emergencies. For these reasons they should have every mechanical appliance to save time and labor in getting under way and working ship and guns, and should have men enough to furnish parties for all kinds of detached service and reserves in action.

The complement of an efficient man-of-war should be fixed with a view to utilizing as many men as possible for attack and defense. It is not to be determined by counting the men required to man the great guns in her battery, nor does it depend upon the area of her sails, or the force required to handle them with primitive appliances. In fact, no arbitrary limits should be assigned. As many men as possible should be carried and trained to do their part in action. The practical basis for determining the complement is the berthing accommodation of the ship. Every improvement in lighting and ventilation can thus be made directly useful in promoting efficiency by obviating the disadvantages of large crews in contracted quarters.

There must not be a reduced complement in time of peace for the few ships of modern type which we can put in commission. Every one of them must be made a training-ship for all the men that can be carried. Modern ships and modern weapons must be utilized to afford real and practical training for modern warfare.

The complement of officers must vary with the number of the crew. While a small number of officers might suffice for navigating a ship on regular voyages, it is evident that an increase will be required if a large body of men are placed on board to be disciplined, instructed, and commanded in action. But tradition has its arbitrary standards,

and requires four watch-officers for all men-of-war. Strict watch duty must be carried on in gunboats of obsolete type and worthless armament, and officers must be detailed accordingly. This may leave only one or two more line officers in a ship carrying 500 men than are nominally employed with a crew of 30. Against such customs of the service it is the purpose of this essay to appeal. It is maintained that there is an essential relation between the number of officers and the fighting force of the ship. A further attempt will be made to give approximate rules for determining the proportion of officers and men. There must be a certain natural relation involved.

The engineer's force is charged with the work of furnishing the ship with motive power for use in action and on all occasions of emergency. It is therefore an essential part of the fighting organization and should have a liberal allowance of men. The working force should be sufficient for long passages under steam, and some provision for a reserve is also required. This reserve should be drawn from a contingent of landsmen forming part of the complement of every ship. They should be trained and drilled with the ordinary working and fighting force of the ship and encouraged to fit themselves for advancement to higher ratings, either as seamen or firemen, according to aptitude.

This brings up the question of recruiting, and may serve as an excuse for some discussion of its problems. The supply of continuous-service men trained in ships of war is not sufficient for our needs. By offering high wages in the open market we can get seamen quite equal to those who man the remaining ships of our unfortunate merchant marine. This class is, however, largely made up of foreigners.

It would be easy to exaggerate the disadvantages of this fact. The figures showing the nationality of any of our ships' companies would convey an unnecessarily alarming impression to most people. This is not a new or startling condition of things in the naval service of the United States. It is not, however, a condition with which we ought to be thoroughly satisfied, even in time of peace. In war it might give rise to serious inconveniences and complications. The inevitable failure of such a supply in time of urgent need can hardly be provided for. We could not then afford to train recruits whose first step must be the acquisition of the English language. Those we have trained may be relied upon as long as they are willing to remain in the service.

The naval-apprentice system is an attempt to Americanize the Navy by a supply of trained men for continuous service. The figures which should demonstrate the success or failure of this attempt are not available. Nevertheless, there is reason to believe that there has been a failure in its numerical results. It would be interesting to compare the number of graduates from our training ships, now serving as seamen or petty officers, with the total number of those who have been enlisted or who have passed through the prescribed course during the last ten years. If the percentage turned out to be inconsiderable as compared with the total number of seamen required for the Navy, it would be hard to justify the maintenance of the training squadron on its present basis, with its fleet of obsolete ships and its large staff of officers withdrawn from service under normal conditions, in ships of modern type and armament.

Consideration seems to show that we cannot with safety and propriety continue our reliance upon the mercantile marine for a supply of trained seamen, and that our apprentice system is slow and inadequate in its supply of continuous-service men. We are therefore thrown back on the source of supply which will be our inevitable dependence in time of war. Let us enlist young men of good physique and intelligence and give them a rapid course of military training while they are acquiring the rudiments of seamanship by serving in cruising vessels. France and Germany have their whole maritime population to draw naval recruits from, yet they are compelled to accept men from the general conscription, without regard to nautical experience. This element forms a respectable contingent on board men-of-war of those countries, and they show no marked inferiority when drilled with the merchant seamen and fishermen of the regular enrollment.

All these facts seem to favor the plan of enlisting men under 25 for general service with a view to their advancement, according to ability, after a practical course of training. They should be liable to discharge at the end of six months, at the discretion of commanding officers, if they are found unfit for the naval service. They should be trained in cruising vessels on the home station. Increased pay and privileges, as well as distinguishing marks in uniform, should be used as inducements to work and improvement. They should not be called landsmen. The naval use of this word implies tendencies to stupidity and stagnation which are not desirable. They might be designated as mariners, or naval volunteers, before advancement to

higher ratings. Their number should not exceed 25 per cent. of the complement of any seagoing vessel.

The training system should be kept up on a reduced basis to furnish trained men for special or technical work in connection with the armament and equipment of ships of modern type. Methods of training and principles of selection should be modified accordingly. The Government should in all cases reserve the right to get rid of bad bargains without waiting for the expiration of any fixed term.

The marine corps furnishes a valuable element in our ships' companies. Its services as a police force are invaluable, and justify its continuance in spite of the want of adaptability of its system of training to nautical conditions and modern weapons. These drawbacks are manifest enough to suggest the limitation of the marine guard of each ship to the smallest number which can be trusted to perform the strictly necessary sentry and police duties; otherwise they exclude men who might receive a thorough naval training from our few modern ships. It does not seem practicable to make any use of the nautical training and education possessed by the younger officers of the corps. The old routine restricts their usefulness, while their presence in small ships keeps out line officers who should be gaining experience and performing responsible duties.

The maintenance of strong marine battalions at two or three central stations would furnish the corps with opportunities for advanced military instruction, and the country with an organized force for detached service. From these battalions temporary details for guarding navy yards and public property could be readily made. Guards for ships should be made up of trained men only, who should receive a slight increase of pay for sea service. Two officers to each squadron would be sufficient to inspect and organize the marine guards of all the ships. Qualified sergeants and corporals should act as guides at battalion drills, and might serve as instructors for seamen in the manual and marksmanship where junior officers were wanting.

The recently established courses of instruction in ordnance for continuous-service men should provide the Navy with qualified instructors for the elements of gunnery and rifle practice. They should drill recruits under the direction of division officers, and the latter should be required to devote the time saved from drudgery to the advanced instruction of capable men.

It would be well to apply in this connection the principle of official

responsibility as the basis of all military organization. Petty officers of all grades must take their share of responsibility, and commissioned officers must be held responsible for results, while allowed to act for themselves in directing details and methods of training. Routine and regulations must leave something to be settled by commanding officers of ships and officers of divisions.

The watch bill is the foundation of our present system of drill and discipline. It is so ingenious and flexible in its methods that it can be adapted to ships of any class without essential modification. It should be given more continuous vitality by working and drilling its subdivisions, its watches and quarter watches, as active, organic units in port as well as at sea. Captains of parts of the ship should be supported and made to acquire a sense of responsibility for their men's presence and performance in answer to any call. Watches should be mustered daily in port, and parts of the ship should be preferred to mixed details in executing work of any kind. Organization and drill must combine to prevent the watch bill from losing its vital powers during a long stay in port. Work must be found for men in port to maintain physical training and discipline. But the force should be accurately proportioned to the work to be done, and the men designated must use their energies in working. Calling all hands to do the work of a watch encourages the idle to stay away, or to shirk when work is in progress. Each watch should have its strength developed by drill, and its organization perfected by careful stations and musters.

The station bills for working and sailing the ship adapt themselves readily to the watch bill. The force is always large enough for any rational evolution, and the superfluity of men to be drilled explains and justifies some combinations and exercises which might be found fantastic from a purely practical point of view.

The quarter bill or fighting organization must be regulated by more severe principles, while motive and manœuvring power must be maintained at the highest standard during action. Modern ships bristle with weapons requiring men to work them. Neither attack nor defense can afford to neglect any source of strength. Ships must be prepared to steam and manœuvre while large portions of their crews are on detached service. Finally, we must provide for a vigorous course of training which shall utilize and develop the fighting powers of every man in the ship. Men learn to sail a ship after a fashion, without special training, because they cannot help

taking part in the necessary work. They cannot, however, be trusted to pick up the art of fighting with great guns and small-arms, machine guns and torpedoes, without thorough organization and training.

Our present methods appear to recognize these necessities in principle. In practice they must be modified, to be thoroughly useful with modern armaments. Instead of forming a division of convenient size as a unit of organization for fighting and military training, we now distribute the material of the armament into groups and attach officers and men to guns, magazines or gear, according to arbitrary rules. The groups thus formed are called divisions, and form the basis of all subsequent organization and training. The idea of seniority is attached to these groups of material, and the removal of one officer breaks up all connection between those below him and the men for whose training they are responsible.

The gun divisions are generally fairly equal in force. The navigator's division varies greatly in size and efficiency. It may have five men or one hundred, but its commanding officer is rarely in a position to instruct it during drill hours, or to command it as a whole during action. The powder division is largely made up of inefficient men, who give a character to the whole organization and prevent the improvement of the rest. They are broken up in squads when stationed to pass ammunition, and usually receive only rudimentary instruction. They may do the work for which they are stationed, but they do it with much waste of numbers and strength, and in other respects make little progress towards military efficiency. The engineer's division is not drilled at all. Thus, only about one-half the ship's company receive a thorough course of training, or can do so under the present organization.

It is claimed that every man should belong to an efficient military organization, and should be trained for every kind of service according to his abilities. The great guns are only parts of the armament, and must not control the whole organization. The close connection between men and material is only important at the beginning of a cruise, and is not to be preferred to the connection between divisions and their commanding officers, which is now so often interrupted. To properly distribute work and responsibility, the divisions should be of uniform size and should be expected to receive equal amounts of training.

It is proposed to deduct from the ship's company the engineer's

force, marines, and first-class petty officers, and to distribute the remainder in divisions of forty to fifty men each, and of nearly identical composition. These divisions will be assigned to portions of the armament, keeping at least one division on the spar-deck for working ship. The powder division disappears, and each division has its own chain of ammunition passers. The navigator confines himself to his duties as ordnance officer and officer of the deck in action. The divisions are commanded by lieutenants, assisted by ensigns if possible. It should be the purpose of the detail of men to equalize the force, and to make the divisions complete working detachments. Progressive instruction should be given with a view to making the divisions interchangeable, but they should not be shifted unnecessarily. The connection between the lieutenant and his division should be permanent, as far as practicable. Messes should be arranged by divisions and watches, as far as practicable.

While all divisions should be instructed in the use of various weapons and prepared for detached service, it may be convenient in practice to class about one-fourth the men of each division as reserves to remain on board when more than two divisions are detached for other duty. This reserve would naturally be made up of coal-heavers, servants, rated men, and a few petty officers. The absence of men of these classes from daily drills may be tolerated at the discretion of the commanding officer. A record of all such absences should be kept and presented for inspection on occasion. The divisions should be paired to be combined under either of the lieutenants as a company of infantry, when the reserves are not landed, and when it is desirable to retain some of the regular division and watch officers on board ship.

The executive officer should have direct command of the whole force employed in working the armament. The navigator should work the ship under the personal direction of the captain. The navigator should have a fixed position in action, but the captain and executive should go where they can best direct the working of the ship and her armament. On no account should the three senior officers of the ship be grouped on the bridge or in the pilot house.

As a detail of organization, the use of telegraphs for working the helm and engines in action may be pointed out as highly important. A system of speaking-tubes to engine rooms, magazines, etc., is also required. Speed should be shown by revolution indicators, and the position of the rudder by a proper pointer, both under the eyes of the commanding officer and navigator. The terrible responsibilities of

command in action do not admit of the distractions of the old system of passing the word.

The practical conclusions drawn from the consideration of methods of organization are two in number:

1. Men must be stationed, worked, and drilled by watches in port, as well as at sea.

2. Divisions must be equal in force and each of them an efficient and complete military organization.

These propositions will be developed in succeeding portions of this essay.

III.—Seamanship and Sailing Drills.

In taking up the question of drill, we have to begin by considering what changes are necessary to sail most effectively our ships of latest type. As seamanship may be defined as the art of sailing ships effectively, we are called upon to draw up a programme for seamanship drills.

The object of seamanship in the mercantile marine is to make good passages. Men-of-war are subject to the additional requirements of keeping the sea in all weathers and sailing in company. Success in either class is measured by comparison of results rather than of methods, which must vary with the rig and propelling power of the ship—supposing the actual motive power to be regularly employed. The purposes and essentials of successful seamanship change slowly, while methods and details change with every improvement in motive power or steering gear.

Looking at seamanship as a practical art, we must study the parts which are undergoing change and adapt ourselves to new methods with the utmost promptness. We can study the practice of the past out of curiosity and to discover the tendencies of nautical progress. If we know what has become obsolete, we shall be ready to recognize what comes in its place.

The opposite view is held by a school which is lucky enough to have Mr. Ruskin as its literary advocate. He holds that seamanship went out when steam and iron came in, and that hemp and oak are the only materials which a seaman can use in learning his profession. A titled English admiral says that no officer can learn any seamanship on board an ironclad.

Reaction is supported in less picturesque but more familiar phrases

in our own service. Seamanship is held to be an exact and arbitrary science, like heraldry or etiquette. The permanent type of ships of war dates from the first half of this century, is ship-rigged, and carries studding sails. The loyal seaman is expected to steam under protest, and to insist upon large sail areas and manœuvring power under sail for all men-of-war. Obsolete ideals and fidelity to tradition are preferred to practical usefulness and professional improvement.

Seamanship drills are to be kept up as factors in the struggle against evolution, the protest against progress, which these crusaders maintain. The old-fashioned military delight in exactly uniform and simultaneous movements still lives in our cruising ships. Sending down royal yards is called a squadron evolution—though Paul Hoste and Darwin would be puzzled alike at such use of the word—and hundreds of men are called on deck to lower three little spars as the colors are hauled down. Those who call these things practical will hardly tolerate suggestions of change. They make a fetich of the mainsail and regard tacking ship as a sacrament, and care nothing for plans for drilling our ships to sail and fight effectively.

The genuine purposes of seamanship drills are two in number:

1. Development of the strength and activity of the ship's company, to promote health and discipline.

2. Preparation for service at sea, with special reference to probable emergencies.

The importance of the first of these purposes is just beginning to be insisted upon by those who fear the discontinuance of the old sail and spar drills. They are defended as gymnastic exercises conducted under the stimulus of competition. This view has its exponents among British naval officers who demand full ship rig as a nautical gymnasium, without much regard to the practical usefulness of the spars or sails in actual cruising. A mainyard 125 feet in length for an ironclad of low freeboard is an extreme case of the application of this doctrine. The actual and visible results of the present system of drills do not allow us to ignore their value as factors in the physical development of seamen. We must, however, seek to get the same results without waste of time, and to that end we must use more simple and direct methods.

If our methods of physical training are slow, wasteful, and indirect in developing the strength of the individuals of our working force, it is largely due to the practice of conducting all drills with all hands on deck, and leaving ordinary work at sea and in port to be carried

on in an unorganized and haphazard manner by watches or smaller detachments. We must correct this by selecting those portions of drills which afford muscular exercise, and applying them to watches or parts of the ship in such proportion that each man shall be called upon to exert his strength fairly and continuously enough to keep him in full training.

Our present system is also defective in preparing men for ordinary duties at sea, and for the most probable emergencies and accidents of a cruise. Exercises are not carried on with any direct purpose of effecting such preparation. Show, smartness, and *ensemble* are the qualities specially cultivated by our competitive drills. Speed is preferred to safety, and external appearance to sound workmanship. By working only for success in a competition in which time is the chief element, we encourage the use of flimsy devices, the "gilguys and gadgets" dear to the heart of the topman in a man-of-war. This introduces an element of danger, as demonstrated by too many fatal accidents at drill. A more serious danger lies in the habitual neglect of security and finish practically taught by such methods. Sails are insecurely bent and reefed and spars imperfectly secured aloft in order to make time; and seamen do not always remember to change their methods when working at sea, even in heavy weather. In port men are sent aloft before the gear is up, and are thus taught to evade the heavy work in a gale of wind at sea, as well as to expose themselves to danger while laying out on the yards.

The invariable practice of calling all hands for spar and sail drills destroys the likeness between exercise and actual work, and deprives seamen of opportunities for individual training aloft. In practice, ships are sailed by one watch at a time, and watch officers must learn to prepare for all probable contingencies with the actual force under their command. It is hardly creditable for a ship's company to have only one set of trained light yardmen during a whole cruise, but that seems to be accepted as a convenient solution of the problems of competitive drill.

Competitive drills with all hands also fail in providing for progressive instruction and continual improvement throughout the cruise. The first six months are occupied with zealous, if not altogether rational, efforts to approximate to the standard of the average cruiser, and success is marked by a cessation of interest and energy in exercising. Progressive instruction should correct this tendency, but it is not practicable to carry it on with a squadron made up of vessels

of various rigs and crews in different stages of training, except by assuming an equality which cannot be maintained in practice. We even go so far as to attempt to establish an arbitrary equality by rigging vessels with superfluous spars and sails which are useful only in ships of different power and tonnage. Happily, our new ships are to have rigs suited to their types, and uniformity has not been preferred to efficiency.

It is claimed that changes in drill are required to secure physical training, preparation for service, and progressive individual instruction. The present methods are not wanting in ingenuity or elaboration. They fail because they consider results as less important than traditions. Their purpose is too general and their routine too inflexible to ensure practical efficiency. They assume and attempt to enforce conditions of equality among ships which are neither true nor desirable for those of modern type. They make drill rather an end than a means of progress. They are based upon the theory that full-rigged ships are the only real men-of-war, and that reaction in that direction must accompany every improvement in steam machinery.

We must not make changes blindly, but must keep the objects of our system always in view. We must begin with rudimentary exercises and make our routine progressive. This implies the selection of simple operations for muscular training and discipline, and the assignment of men enough to perform them smartly and without opportunities for shirking. Exercises will require constant repetition at first to secure active and organized movement among masses of untrained men, and to promote individual instruction for those charged with special duties. Competition must be postponed until there is no necessity for the repetition of details. After details have been mastered and watches have been trained for their work at sea, combined exercises may be ordered and all hands worked together. These combined exercises should aim at substantial results of practical importance. They may be ordered for squadron exercises where ships are reasonably fitted to compete with each other. The comparison must be directed to results, and the simultaneous execution of detailed movements should be no part of the programme.

Competition should begin between watches, or among individuals and parts of the ship. Its premature application to fleet exercises will tend to cause hasty and inefficient work aloft and noise and confusion on deck. By concentrating the attention of officers during

the progress of an evolution, better work will be secured. Drilling by the motions is not necessary even for soldiers in actual service, and invites accident in men-of-war. A deliberate comparison of the completed work after each evolution will afford the best test of efficiency. Times should be noted, but only used as one element in comparing results. Thoroughness should be the first requisite, and quiet and orderly work should also be insisted upon.

But we must not linger too long in the prolixities of general discussion. Detailed and specific suggestions must be brought forward. Their presentation does not imply any intention of furnishing an absolute and invariable programme for ships of any class. The system must be flexible to ensure responsibility for results, and it must be experimental to encourage progress.

Let us take hoisting boats and bracing yards as elementary exercises important enough to be organized, and vigorous enough to be useful in developing the strength of the crew. The weight of boats being known, it should not be impossible to assign the proper force to hoist each or all of them. At any rate, a division by watches should be made and enforced whenever boats are hoisted. Squaring yards should never take all hands unless they are on deck for other purposes. As a rule, one watch should square yards while the other is cleaning ship in the morning watch. To make an exercise of it, the yards should first be braced up and then squared together. The men should be carefully stationed at the braces and the work done smartly. To complete preparations for steaming against a headwind, the topsail yards might be mastheaded and braced up, and then lowered and squared with the rest. This is a suitable harbor exercise in all weather, and could be made spirited as well as useful, especially when a ship is first commissioned.

The work of loosing and furling sails in port should ordinarily be done by one watch. The other watch may be called on deck to man gear, but the working watch should frequently be sent aloft to prepare them for service at sea. They should also be stationed and drilled in setting all fore and aft sails together, and in hoisting topsails or setting other sails according to the force required. Shifting one topsail at a time is also a suitable watch drill, as it represents the only probable necessity of cruising under sail. Reefing comes last in the order of sail exercises for a watch. Still, it is often better not to call all hands to reef, and stations and drill should prepare the watches to do the work, as well as to shake out reefs in a smart and seamanlike manner.

Sending down light spars is also an operation for half rather than the whole of a ship's company. Sending them up together may require all hands, but it seems absurd to call on more than a quarter watch to work royal yards with the sails unbent. The advantages of having two or more sets of trained light yardmen are sufficiently evident.

None of these drills should be competitive between ships until they have been in commission for several months. Competition between watches and parts of the ship may be encouraged from the first. While the main object of these drills is to prepare watches for service at sea, it is evident that they would also provide the best preliminary training for more complicated exercises with all hands. In making combinations, we should keep in view the conditions and emergencies of practical navigation. No conventional or retrograde system should be established for the sake of uniformity or competition.

The system of watch drills should be kept up even after exercises with all hands have been attempted with success. It affords opportunities for repetition, and for successive and individual training. While the executive officer should superintend all drills, he should require the regular watch officers to carry on exercises with watches or parts of the ship. The morning watch could almost always be made to spare half an hour for one watch to drill in. Of course exercises should alternate, so as to train both watches.

Combined exercises or drills with all hands should be arranged for operations too heavy for a watch, and also with a view to competition between trained crews in ships of similar type. In such competitions a visible result should always terminate the evolution indicated by signal, and this result should have some practical meaning. For instance, a ship in port should be directed to prepare for getting under way, under either steam or sail, the signal indicating what spars were to be sent up or down. Four conventional rigs might thus be ordered by special signals.

1. Harbor rig for neatness and uniformity. Topgallant yards crossed; sails bent or unbent according to climate and convenience.

2. Sailing rig. Sails bent and gear rove off; boats up and booms alongside.

3. Steaming rig. Light spars on deck; yards ready for bracing sharp up; topsail yards mastheaded; covers on boats, etc.; fore and aft sail ready.

4. Fighting rig. Spars which might interfere with the battery

sent down and got ready for rafting ashore, or securing in booms; all gear likely to foul screws unrove or stopped in snugly.

The amount of work to be done by each ship should be settled as soon as she joins a squadron, and should depend upon her peculiarities of construction or equipment. Clearing ship for action should not degenerate into trivialities, such as sending down royal yards and unshipping hatch railings. The fact that a general clearance of superfluous spars and rigging must precede active war service at sea should be recognized.

For the purpose of keeping up activity and interest in seamanship exercises throughout the cruise, certain revivals of manœuvres may be tolerated. Crews may be exercised in shortening sail as though a flying moor were to be attempted. Tacking and wearing, box-hauling and chapelling ship, may occupy leisure hours, in light breezes, with some benefit to officers and crews. Still, these evolutions must not be allowed to usurp time and attention at the expense of more practical exercises. Captains do not care to sail into crowded harbors, or to beat through narrow channels. We have gained so much by the adoption of steam power that we ought to be resigned to the inevitable accompanying loss of sail power. Steamers of high manœuvring power under sail are not found among vessels of the latest types, and this essay is not intended to provide for their management.

While we are attempting to perfect the ideal training of our officers by putting full-powered steamers through obsolete evolutions under sail, little or nothing is done to give them experience in handling vessels in fighting condition—that is, under full steam power. The essential point of the seamanship of to-day lies just here. To avoid collisions on the high seas, officers of mail steamers, acting under the international rules of the road, are compelled to use the utmost vigilance, and to employ telegraphs, steam steering-gear, and every device of nautical science. To avoid rams and torpedoes, to attack an enemy or assist a friend, in the desperate *mêlée* of a modern naval action, will require still more dexterity and judgment. Can we leave our officers to pick up this essential knowledge, or shall we give them practical opportunities for acquiring it?

The palpable neglect of such opportunities in the naval service is due to a variety of reasons. In the first place, our manuals for study are without precepts, and our examinations for promotion are without questions calculated to develop a practical interest in the handling of

ships under steam. The standards of the past prefer sail to steam under all conditions, and treat steaming as a means of evading all nautical difficulties and responsibilities. Moreover, evolutions under steam require coal, and a certain opprobrium attaches to the expenditure of coal except in making passages where haste is ordered. We must learn to be practical in educating our officers, and to be liberal in ascertaining and developing the manœuvring power of our ships at full speed. Squadron evolutions will hardly serve our turn while they are regulated by a meaningless, rectangular system of tactics, and by the powers of the inevitable cripples, with leaky boilers and rattle-trap engines.

We must cultivate the manœuvring power of individual ships as a basis, or rather as a substitute, for all existing schemes of naval tactics. The first step should be to ascertain the actual tactical diameters and other data by experiment, and to familiarize officers with their meaning and use. This may not be what is understood by drill, but it is necessary to efficiency, and may serve as an introduction to other valuable exercises. Officers should be exercised in picking up moorings, in laying out targets, and in piloting the ship, to learn how to keep her under perfect control. Ramming rafts or other light obstructions, and dodging attacks by steam launches, are more specially warlike exercises which should follow in their turn. The problems of handling modern ships under steam are as varied as in the days of sail power. They require to be artificially repeated to give abundant practice for all the responsible sea officers of each ship. Time and coal must be allowed for such exercises, and as many of the officers and petty officers as possible must be employed in observing and noting results, as well as in working the helm and engines. The works of Captain Colomb will be of great assistance in elaborating details, as well as in demonstrating the necessity for such training.

While insisting upon the necessity for watch drills as required to train crews for actual service at sea, we should not ignore certain other advantages of the proposed methods. They should allow two or more operations, such as unmooring, taking in stores, hoisting boats, etc., to go on simultaneously. With a steam capstan it is wasteful to keep all hands standing by while a dozen men are heaving in a long scope of chain or picking up an anchor. Catting and fishing must of course be done by steam power, and a ship should be ready to get under way with a quarter watch. The rest of the ship's com-

pany might be hoisting boats, making sail or manning the guns. The military necessities of a vessel of war give additional importance to the training of detachments to do what is essential to get the ship under way and to navigate her.

Another disadvantage of the routine of drill is felt whenever a large liberty party is absent, or when firemen are cleaning or repairing the engines in port or working them at sea. It is also felt by the officers whenever drill hours and meal hours come too close together. In fact, useful exercises are often omitted from a dislike of mutilating the arrangements of the station bill, inaugurating an unfair competition, or interrupting preparations for meals. The training of the working force of the ship should not be sacrificed to such considerations. If servants and firemen must be drilled to aid in working ship, they should be exercised in manning gear, bracing yards, etc., at convenient hours. Without such preliminary work they are useless when called on deck with all hands, and actually interfere with the training of the seamen and ordinary seamen of the ship.

The solution of the ubiquitous servant problem may be found in a large reduction in the number allowed, to be compensated for by training in their special duties and by the introduction of modern improvements in lighting officers' quarters and in supplying water, etc. This, with a rational disposition of galley and pantry, hot-water supply, etc., and the detail of men to keep officers' quarters clean, will allow a large reduction without any sacrifice of comfort or convenience.

The use of modern domestic appliances should also facilitate cleaning ship, and thus leave time for regular and systematic exercises by watches during the morning or at other suitable hours. Watches should alternate in cleaning ship and exercising. At certain stations, in cold weather, scrubbing should be postponed until some hours after sunrise, and drill substituted during the hours before breakfast. Sanitary considerations are opposed to the indiscriminate use of water in cleaning lower decks, and the use of soft coal for distilling and similar purposes, in port, will discourage wetting even the spar deck unnecessarily, if apparent cleanliness is desired. The liberal use of fresh water, hot or cold, in cleaning decks and paint-work, is also a means of saving time. We might even borrow a hint from the domestic economy of our own homes and from the practice of foreign services in regard to scrubbing seamen's clothing. If tubs or tanks of hot

water for soaking soiled clothing, rubbed with soap over-night, were provided, it would be easy to save half an hour of the morning watch for purposes of instruction. Neatness would also be promoted, and wear and tear of clothing obviated. The use of steam dryers in large ships offers similar advantages.

The station bill, either for all hands or for one watch, should be used to muster men for exercises, so that they may acquire the habit of prompt attendance and may learn to find the gear. A period of fifteen minutes, before or after supper, would serve to prepare a watch or ship's company for a morning exercise.

Besides the general training given to the watches, we should provide for instructing smaller portions of the ship's company, parts of the ship, divisions, or boats' crews, in the performance of special duties. Fitting rigging, fishing spars, constructing jury rudders or sea anchors, are suitable operations to be performed on board ship by working parties under the charge of proper officers. Organized groups should always be assigned to such tasks.

Boats' crews should be employed in a variety of similar undertakings, running lines, carrying out anchors, etc. These exercises may be made competitive in a squadron with advantage. The use of boats as means for affording physical and nautical training should also be recognized and extended. The irregular requirements of service for landing and other duties will not suffice. Nor will the usual exercises in arming and equipping boats and manœuvring by signal serve our purpose. Boats must be called away for sailing or rowing exercise alone, and sent out in groups or pairs to instruct their crews. One officer can control two or more boats, and can learn as well as teach during the drill. The effect of sails, the use of the rudder, and the principles of old-fashioned seamanship, can be learned more rapidly in boats than elsewhere.

The same principles apply to the use of steam launches, which must form a larger part of the outfit of ships of modern type. Their usefulness in towing other boats is an essential feature which requires notice and development. The speed of a launch towing a string of boats should be accurately measured and recorded, with the time required to get up steam, and other data of military significance. The armament and instruction of boats' crews for various kinds of detached service will receive notice in succeeding pages. The present suggestions deal with the use of boats to supplement sail and spar drills in developing the strength of seamen and instructing them in the elements of seamanship.

Individual instruction in seamanship must largely be left to the operation of natural causes. We assume a certain amount of training and assign duties in navigating the ship accordingly. Men learn by daily experience and by association with petty officers. We are not called upon to make radical and elaborate suggestions and rules for teaching everything connected with this subject. Ships are sailed continually, but fought very seldom. We must therefore concentrate our attention upon the methods required to make men comprehend naval warfare and to prepare them for action.

The improvement of individual seamen can be provided for by offering higher ratings to those who are qualified. The limits of the complement should not prevent such advancements, at least during the latter part of the cruise. There is some absurdity in discharging men of good physique and intelligence as landsmen or ordinary seamen after three years' service in a man-of-war. Here, as elsewhere, we must rely upon the setting up of standards for encouraging and securing progress. Let the qualifications of each rating be definitely stated and permission given for all men of approved character to present themselves for examination. One year's service before advancement and one year's interval after failure should be required from recruits or other candidates. Liberality in this direction will encourage useful and practical self-education.

In bringing this lengthy and discursive chapter to a close no attempt will be made to summarize all its conclusions. The principle insisted upon is that drills should be established with a practical purpose in view, and that the object must never be sacrificed to conventional or traditional standards. Of the two objects put forward here —physical culture and preparation for service—the first admits of some latitude in the selection of methods by which it may be secured. While practical views must be accepted, we need not be too severe in applying them to exercises which have the advantages of being familiar and showy in the eyes of old men-of-war's-men. We may continue to tack and wear, loose and furl sails, and send down top-gallant-masts with all hands, if we remember the prime necessities of giving each man his share of a day's work and preparing the watches to do their duty at sea. If these essentials are neglected, no exactness in the swaying of yards together can make the ship efficient. The necessity for drilling squadrons by the motions is not apparent to the writer, who is even prepared to assert that there is no sense in combining the ceremonial of colors with practical exercises in seamanship.

In spite of such a degree of radicalism, it is impossible to leave the consideration of this section of our subject without expressing some toleration for the old drills which we may find means of retaining, and some regrets for those which must be rejected as obsolete. When methods of fighting are taken up in turn, we must, however, waive all sentimental sympathies and be severely practical and progressive.

IV.—Armament and Preparation for Battle.

Preparation for battle must be the watchword of all systems of organization and instruction for men-of-war. Armament and training must be alike rational and progressive. Nor will it answer to postpone this preparation until war is at hand. This would make our naval battles mere experiments, offering us solutions of professional problems at the expense of our ships. The study of all the experiments and failures made by foreign powers becomes a question of safety as well as efficiency to our service. The work of noting the facts may be left to the Office of Naval Intelligence, as now happily organized, but the observed results must be analyzed and published for the use of all officers, if our ships are to be prepared for actual warfare.

We need not, however, wait any longer for information to accumulate proof of the necessity of radical changes in our methods of attack and defense. It is not even necessary to look outside the armament of ships now in commission to realize the failure of our present system of drill in developing and utilizing the powers of modern weapons. The introduction of new weapons will only serve to make this failure more conspicuous.

At present the battery of great guns is treated as representing the fighting power of the ship under all conditions. In ships with rams this method of attack is practically ignored. Spars are permanently fitted to interfere with its use; and the officers are not assisted by telegraphs or trained by full-speed trials to manœuvre their ships in action. Spar torpedoes exploded by electricity are fitted to ships, but no precepts are laid down to regulate their use in action. It has been held that even large and slow ships might surprise an enemy at anchor and attack with this weapon. It is now hinted that ramming attacks may be averted by employing it. The first view requires no discussion. For the second suggestion there is the fact that ships

cannot surrender any part of their speed or turning power to employ such an uncertain weapon as the spar torpedo. Even at anchor the spar torpedo is inferior to a group of mines.

The only methods of attack and defense for which our Ordnance Instructions provide in detail are those by boarding. The principal use of machine guns is said to be "to prepare and clear the way for the boarders." Small-arm fire is reserved for the same improbable occasions. Riflemen and marines are rarely called on deck at general quarters, except to support or repel boarders. In the latter case they may be supported by a heterogeneous mass of men armed with all kinds of archaic instruments of warfare. Every general inspection sees crowds of men wildly rallying and charging about on uncovered decks in imaginary action. Can we suppose that our seamen can be made to take such drills seriously when in port with foreign ships whose tops and bulwarks bristle with Hotchkiss guns?

Nothing is done to develop the powers of these weapons to keep down the artillery fire of an enemy or to interfere with the command and steering of his vessels in action. Nor are commanding officers directed to organize or instruct their small-arm men or machine guns' crews to repel torpedo boats. If this means of defense is neglected, it will be idle to expect any amount of "ingenuity" to keep our ships afloat in war-time. In fact, the whole scheme of attack and defense may be set down as antiquated and inefficient.

This criticism does not involve any reflection upon those who administer our present system. Most of these defects are due to tradition or to the survival of obsolete material. Our system of drills is only a little behind our armaments. Our armaments are quite as good in their kind as our ships. The ships themselves are no worse than they should be, considering their age and the methods of administration under which they have been designed, constructed, and repaired.

Considering the armament of our ships of latest type as the basis of the proposed drill programme, we have, in the first place, high-powered, breech-loading rifled cannon to replace the smooth-bores so long retained. It is evident that this change must seriously modify the methods of aiming and firing, unless all the advantages of rifled guns are to be sacrificed. Auxiliary batteries of Hotchkiss revolving cannon are promised for the new cruisers, and rapid-firing shell guns will also be required to complete the armament, if the ships are to be fought effectively. Magazine rifles of approved pattern will also be recognized and supplied as essential to the power of the ship

in action and to her defense against torpedoes. They should be accepted as the standard weapon for all landing parties and all boats' crews on detached service. Enough rifles should be put on board to arm at least 80 per cent. of the ship's company.

Among the weapons displaced by modern armaments, we find all smooth-bore guns, from the XV.-inch Dahlgren to the 12-pounder bronze howitzer. The 3-inch rifle—so long the sole specimen of modern ordnance in our collection—will find it hard to keep its place against the intrusion of Hotchkiss rapid-firing guns of high power. The want of a proper rail-mounting has made this gun almost useless up to the present time. As machine guns and magazine rifles have put boarding out of the question, we must anticipate the disappearance of swords and pistols, pikes and battle-axes, as special naval weapons. If cold steel is to be retained at all, it should be in the form of bayonets for magazine rifles. At present, the obsolete cutlass and the impracticable revolver usurp about as much of the time of our officers and men as we devote to the accurate and invaluable magazine rifle.

If we are to differ from foreign navies in dispensing with the automobile torpedoes, we must resign ourselves to making the best of the spar or out-rigger torpedo. This may involve its disuse as a portion of the fighting outfit of our ships, and its practical development as a weapon for steam launches of all types. It is to be hoped that at least one genuine torpedo boat may form part of the equipment of each of our new cruisers. Mines or stationary torpedoes, for use in defending vessels at anchor, may also be supplied. Whatever torpedo armaments may be adopted must have men to work them. The necessity for relief crews in torpedo boats will compel us to train a considerable portion of the ship's company in handling explosives, working torpedo spars, and laying out mines. Every line officer should share in this practical instruction while on sea service. No advanced course in electricity and chemisty is required to prepare officers and men for practical training in the elements of torpedo warfare.

The plan of organization heretofore discussed distributes the complement of all ships into equal and interchangeable divisions of 40 to 50 men each. It remains to develop and apply this scheme to the immediate preparation of the armament for service, and for the progressive military instruction of the crews of our ships of latest type.

As an illustration, let us take the Atlanta as a ship to be organized

according to the plan suggested. Accepting the estimate of 230 men as her complement, on the supposition that she cannot berth a larger number, we have to adjust this force to the armament proposed. In round numbers, we can set off 50 men, including first-class petty officers, a strong engineer's force, and a small marine guard, as already assigned for duty in action. This leaves 180 men, to make up four divisions of 45 men each. Four lieutenants, junior to the navigator, should command these divisions, with junior line officers as assistants. The natural assignment of divisions would put three of them in the superstructure to work the battery, and leave the fourth division to work rapid-firing guns on the upper deck and in the tops, to assist in navigating the ship, and to serve as small-arm men under the direction of their proper officers.

In stationing men at the guns, two reliefs should be assigned to guns having bow and stern fire, to all Hotchkiss guns, and the guns in one broadside. If the mechanical carriages are properly designed and constructed, five men should be able to work each 6-inch gun effectively. For 8-inch guns seven men may be allowed, and for Hotchkiss guns three each. These numbers are intended to admit of the regular relief of crews at short intervals. In French ships five men work 24-centimetre guns, mounted on turn-tables, with great ease and rapidity, and our men should be able to do as well. Men not stationed at the guns should keep up the supply of ammunition.

In detail the allowance for gun divisions would be as follows:

1st and 3d (Forward and After) Divisions.

1st Relief (8-inch B. L. R., 7 men; 6-inch B. L. R., 5 men; 2 Hotchkiss, 3 men each),	18
2d Relief,	18
Ammunition passers,	9
Total,	45

2d (Amidships) Division.

1st Relief (2 6-inch B. L. R., 5 men each; 2 Hotchkiss, 3 men each),	16
2d Relief,	16
Ammunition passers,	13
Total,	45

The advantages of this system will hardly be questioned by those who are willing to admit its practicability. In taking up drills in detail, an effort will be made to deal with all apparent difficulties in its application. In general it will be the duty of the division officer to work his force as a whole, and to employ both reliefs in casting loose and providing the guns, and in removing obstructions and repairing damages during action.

The supply of ammunition by the men of the division may seem to require some explanation. It should be quite as practicable to connect the control of the ammunition passers with the guns which they supply, as it is to maintain the present scattered and loosely organized system. The officer of the powder division of our ships must be ubiquitous, to regulate the working of all the groups and chains of men now stationed to handle ammunition. These chains diverge from his control, while the proposed groups would lead directly from the magazine or shell room to the guns under the direction of the officers working the battery.

It is evident that the present system of supplying powder is a mere survival from the days when ships had several decks and a large number of guns on each. Its elaborate arrangement of chains and scuttles assumes this, and supposes a great variety of guns of similar calibre in the battery. The fact that the handling of projectiles receives such scant attention, indicates the antiquated and unpractical nature of present methods. The real source of delay when firing is going on is in the whipping up of heavy projectiles from the shell rooms. This is largely due to bad stowage and awkward arrangements, which require more care for their correction than is needed to prevent any possibility of mistake in regard to the destination of charges of powder.

Of course, the construction and arrangement of store-rooms for ammunition should assist organization in facilitating rapid and regular supply. In a recent British ironclad each gun has its own magazine and shell room, with a common hatch or elevator for delivering its supply of ammunition. Detached guns of 6-inch calibre were among those thus provided. Without going so far as this in cruising ships, we should try to make progress in this direction. For heavy modern guns this arrangement is the only one that is practicable, and our organization should anticipate the development of our artillery and water-tight compartments with doors closed during action. The stowage and handling of shells might be facilitated by dispensing

with boxes, and strapping the shells so that they should be slung by the point for hoisting and carrying. A block might be fitted over the point to protect the fuse, and a becket attached to metal straps passing under the base. Whipping up long shell in boxes slung in the middle is inconvenient in an ordinary hatchway.

Speaking-tubes should be fitted to allow the executive officer to give preliminary orders to the gunner or gunner's mate in charge in the magazine or shell room, and also to enable officers in charge of gun divisions to call for ammunition. This would be better than relying upon the polyglot contingent at intermediate stations to pass the word, or upon the necessarily intermittent control of the officer of the powder division. Other expedients will be suggested when detailed exercises are under discussion.

The purpose of the proposed organization as adjusted to the battery of the Atlanta is to provide for the immediate readiness of the armament of the ship upon going into commission, as well as for the progressive individual instruction of the members of the crew according to their various capacities. The distribution of the complement of any ship could be regulated by the same principles. A large ship might have two divisions to do the work now done by the navigator's division, and to keep up the fire of light guns and small-arms during action. Moreover, all the relief crews not actually working the guns would always be available as riflemen, firemen, or wreck-clearers. They should be equipped as riflemen whenever the guns are cast loose in action, and rifles and belts for all the men in gun divisions should be distributed in racks ready for use. The relief crews might be sent below for shelter or for rest or refreshment, according to circumstances. The men actually working the guns should not be required to wear accoutrements, or to answer calls individually, though they may be detached in a body to act as riflemen.

Taking up the actual service requirements in their order, we have to arrange a system of exercises for securing two principal objects:

1. The immediate preparation of the whole armament for efficient service in action.

2. The training of all divisions for the performance of various kinds of detached service in time of war.

As we cannot hope for perfect success in either direction in the limits of a three-years' cruise, we must establish a continuous and progressive system of drill and instruction, to accomplish as much as

possible of the desired result. It will not be practicable to sacrifice one of these objects to the other, either in point of time or otherwise. The defense of a ship often requires the detachment of part of her force, as well as the development of the full power of all the weapons which she carries.

We must now attack details and seek out the modifications by which our present mechanical drills can be transformed into a rational and progressive system of individual instruction. The phrase used in making entries in the log is too accurately descriptive; divisions are "drilled according to routine," which means that officers feel very little responsibility and men take very little interest. The suggestion has been made that officers can be made responsible only by allowing them a certain amount of liberty in regard to methods, and requiring the attainment of definite results. This will involve greater permanence in the connection between the divisions and their commanding officers. No general fleeting up or arbitrary scale of precedence should interrupt systematic training.

As a means of encouraging progress, men should be classed according to drill and training, in order to furnish a standard for measuring results and apportioning responsibility. Three classes might be established, as follows: 1st Class.—Trained men: fit to serve as gun captains, file-closers, and coxswains of armed boats. Marksmanship is a prime requisite for admission to this class. To be examined by a board on presentation of names and record of target practice by officer of division. 2d Class.—General-service men: familiar with stations, at guns, infantry drill, and rifle practice. They should be good oarsmen and expert in care of arms and cleaning brightwork. A certain percentage at target practice is essential—say 40 per cent. at 200 yards. 3d Class.—Men who can march with a company, pull in a boat, and fill a station at quarters. Men should be assigned to the second and third classes by the commanding officers of their divisions. Recruits and others should not be classed until they have received a certain amount of instruction. Rating and length of service should not affect this classification. Officers should be encouraged to bring their men forward for the higher classes, and the number in each class, as well as their average proficiency, should be carefully noted at each general inspection. The classification and the marks upon which it is based, including a final average of target practice, should be noted upon each man's discharge or continuous-service certificate.

Any thorough course of progressive instruction must require more time than is allotted to the present routine drills. In port or at sea, in pleasant weather, it will be easy to find unoccupied hours enough during the forenoon to admit of two hours' drill for the body of the crew. An occasional afternoon hour might also be utilized.

All this will impose extra work on those officers whose regular duties involve more exposure and fatigue than those of any other class on board—viz.: the lieutenants who stand watch and command divisions. At sea they have real and responsible duties to perform. In port their presence on deck at all hours and under all conditions is a concession to routine and tradition rather than to any practical necessity. There are plenty of junior officers in the service who are without any regular and responsible duties. They could acquire the habits of command by standing watch in port without risk of impairing the discipline and efficiency of their ships. The simplest solution of the question would be the requirement that all commissioned officers of the line should take charge of the deck in port. The executive and navigator are, of course, excepted, and officers temporarily engaged in other work, such as compiling local information, surveying, or special ordnance or torpedo duties, should also be excused. This would improve the unfortunate position of ensigns, and it would allow lieutenants to give more time and attention to the instruction of their divisions. At sea no change is essential in the distribution of responsibility among officers, though junior officers should have a chance to acquire a practical knowledge of their profession.

It is proposed to establish a system of exercises which will leave no opportunity for wasting the two or three hours off watch which the average lieutenant would gain by putting ensigns on duty. Besides the extra time required for practical exercises, there will be occasion for increased study in preparing progressive courses of instruction. A certain amount of clerical labor is also required from officers in charge of divisions.

Ships with a reduced complement of officers must distribute the responsibility by day's duty. Three watches cannot be carried on in port, with any strictness, without depriving officers of the spirit and energy necessary to secure the thorough training of the men under their command. Works on military hygiene recommend that guard duty should be arranged to give soldiers four nights out of five in bed. Naval officers cannot expect so much consideration, but the

facts of hygiene can hardly be ignored without loss of efficiency. The preceding suggestions are not, however, based on such grounds. They are made with a view to professional improvement among the officers and practical efficiency for ships' companies.

I am tempted to add, as a mere personal expression of opinion, that I see no harm in allowing the officer of the deck, in a well-disciplined and securely anchored ship, to stand part of his night watches in a conveniently situated chart room or pilot house on the upper deck. While there, he might occupy himself with professional study or work in connection with his duties as a division officer. Concessions of this kind, if properly regulated and recognized, would do more to secure vigilance and intelligence in the performance of duty than the mechanical routine of walking the watch realizes in practice. This suggestion is commended to the use of the naval authorities of Utopia, as I am aware that it will not be received with favor by those who control American ships of war of any type.

The details of a drill system we may well begin with the great guns. The introduction of mechanical and automatic carriages should promote accuracy and rapidity of fire and simplify drill by reducing the number of men stationed to work the guns. These changes tend to render great-gun drills less suited to competition,—less active, and, therefore, less useful as a muscular exercise. The guns can no longer be sent crashing into the water-ways in running out, as in the old days of four-truck carriages, with their tackles and handspikes. We must rely upon mechanism to work high-powered guns, and crews must be made familiar with its details and taught to keep it in perfect order.

To ensure the proper condition of the battery, the usual morning inspection at quarters should always include an examination of the guns and their carriages. After mustering the men and inspecting their clothing, the guns should be cast loose, run out, trained, run in, and secured by the proper orders, with strict attention to details, as well as to the condition of the gearing, hydraulic cylinders, and brightwork. The breech should also be opened and the bore of the gun examined. This will prevent the rusting and sticking of parts which sometimes occur. While one relief is working the guns, the other should be inspected as riflemen, and the ammunition passers should be put through their stations. Both reliefs would be required to work the broadside guns. At other divisions, they should alternate as guns' crews and riflemen. Fifteen minutes should be allowed for muster and inspection, which should be thorough and practical,

and conducted as a strict military formation. This exercise should serve to keep the crews as well as the guns in good working order, and should take the place of longer great-gun drills, which are apt to become very tedious with mechanical carriages.

The only real test for efficiency of armament in a man-of-war is the rapidity and accuracy of fire. The most important drill must be that which most directly secures progress in that direction. In practice, delays in firing are more often due to the imperfect training of gun captains than to any other cause. Misses and wild shooting are due to the same deficiency. The supply of ammunition and the loading and training are all minor difficulties. Quick and accurate sighting has not yet been mastered by any considerable proportion of our continuous-service men. This must be attributed to want of systematic instruction and practice. The object of quarterly target practice seems to be the transmission of reports to the Bureau of Ordnance. Certainly it is not the custom to publish the records or diagrams for the information and encouragement of divisions. Hardly any appeal to the intelligence of men is made to avoid waste of ammunition, and the simple methods of comparison of records, by which earnest competition might be inaugurated between ships or between divisions, are altogether ignored. Our failure to utilize the results of target practice is accompanied by neglect of the training necessary to prepare for target practice.

The recognition of aiming drill as a necessity in preparing for effective fighting, must involve the assignment of regular periods for the instruction of all men capable of improvement. Advanced training for the best men, and elementary instruction for all, will require the attention of division officers during the whole cruise. Instruction in aiming should be the regular exercise with great guns and all rapid-firing guns. The crews will be made familiar with the mechanism of the carriages and slides by the regular morning inspection of the battery. Loading may be taught incidentally during the drill, using dummy cartridges and projectiles, and the necessary information in regard to ammunition, stations, etc., may be given to the more ignorant portion of the crew while aiming drill is in progress. The latter should be taught by the officer of the division who will be called upon to regulate firing in action. Rudimentary instruction should be given by junior officers, assisted by qualified petty officers.

The details of instruction should be practical and varied enough to be always interesting. This will involve an active interest on the part

of division officers, and some extra work in measuring distances from the chart to be used in teaching the men how to estimate distance and use their sights. By keeping records of the progress of each man, by connecting the training in pointing with actual practice through inspection of targets and explanation of diagrams, and by using competitive exercises to incite progress, results of the highest value may be attained. Times required for sighting should be noted; men should be called up to verify the point of aim for which a gun has been laid by a gun captain; rapid-firing guns should be made to follow a moving object, using the open sights. Valuable suggestions will be found in the "Handbook of the Hotchkiss Rapid-Firing Gun," by Lieutenant E. W. Very. The methods of the Army Manual of Rifle Practice may also be adapted to naval uses with guns of all calibres. Aiming drill should occupy about half an hour two or three times each week.

Considering rifle fire as a means of supporting the fire of the battery and keeping down an enemy's fire or interfering with his steering in action, the necessity for careful training in aiming and firing will be manifest to all. Without such training with small-arms, no ship is fit for active service, or even to defend herself against attack by torpedo boats. Aiming drill with rifles should lead up to similar exercise with great guns, as well as to target practice. Aiming should be taught by the latest and most approved manuals, and should occupy about the same time each week as the corresponding exercise with great guns. This claim does not arise from any purpose of turning sailors into soldiers. This is not yet under discussion; but it must be admitted that marksmanship is required to fight a ship effectively just as much as seamanship is for efficient navigation. Rifle practice must be taught for use on board ships, in tops or boats, and riflemen must learn to distribute themselves properly, to concentrate their fire, to fire volleys at the word, and to take advantage of the bulwarks for cover and for resting their pieces in firing.

Aiming drill must be followed by target practice, which is, perhaps, the most practical of all military exercises. Drill generally consists in going through the motions without accomplishing anything. Target practice gives an actual result and furnishes an absolute standard for measuring efficiency. It must be taken seriously and made as thorough and practicable as possible.

Among the drawbacks which make naval target practice ineffective in securing marksmanship, a few require mention. Men are sent out

for practice before they have received any aiming drill or fired any blank cartridge. They fire over too long ranges or at small targets which they are unable to hit, or at floating or swinging targets for which it is impossible to keep scores. If a man fires five or ten rounds without seeing where his shots strike or learning to correct his aim, he has wasted his ammunition. If he makes a clean score of misses without finding out why he fails to hit, his chances of becoming a marksman and his value as a man-of-war's-man have been injured instead of improved.

Remedies will suggest themselves to any one who realizes the importance of the subject. Preliminary aiming drill is indispensable. Ranges and targets must be adapted to the circumstances and the qualifications of the men firing. Scoring must be thorough, and the result of each shot should be signalled. Markers must be trained and scores must be shown to the men. Finally, the officer in charge of the firing must be required to give his best attention to the firing of each man. This may involve a reduction in the number of men taken on shore, and it will certainly require a police force for all ranges outside of navy yards. Seamen cannot be expected to shoot well with their worst enemy—liquor—taking them in rear. A detail of a corporal's guard of marines would often enable an officer to improve the shooting of his division 50 per cent.

For naval uses, canvas targets should be supplied, to be laced to uprights of iron plates or light angle irons with wire guys to support them. Squares of old canvas would answer, with ready-marked facings of paper to be pasted on, or muslin to be stitched on, to renew them. No difficulty would be found in transporting such targets, and no time would be lost in setting them up, if markers are properly instructed before they leave the ship. Miniature targets for use with parlor rifles are also indispensable for use on board ship.

As a means of securing permanent benefits from target practice, complete records should be kept and brought forward on all occasions to interest the men and incite them to improvement. Competition between different organizations should also be encouraged by comparing averages and results of volley-firing. The individual scores may be made most useful by furnishing each man with a small score-book, wherein each shot that he fires, either with rifle, machine gun, or great gun, should be entered, and the score certified by his division officer. The production of these scores should be made a feature of general inspections, and their significance should be constantly impressed upon the men during instruction.

The same books should have pages and forms for keeping clothing lists, making requisitions, etc. They should be used and verified whenever clothing is overhauled and inspected. All entries should remain in pencil until after verification by responsible officers. Nearly all of our men can write, and they should be encouraged to make so much use of their education as would be involved in making these entries. The same note-books might contain a few pages of instructions in regard to gunnery, stations, and other particularly useful information. They should be small and well bound in soft leather. They would improve marksmanship enough to pay for their cost in a single quarter, if we count all ammunition wasted which does not result in hits, as we should always teach seamen to regard it.

Combined target practice at sea must also have its standards and methods of scoring. The targets should be large enough to catch all shots properly aimed from rapid-firing guns and small-arms. Diagrams for plotting great-gun practice should be used in the same connection, and all results and records exhibited and explained to the men engaged in firing. Lieutenant Very says, in the manual previously mentioned: "As much is to be learned by studying the targets made as by the actual shooting."

It may be necessary to use arbitrary and approximate methods in recording great-gun practice at sea; but some methods of comparison are essential if men are to derive encouragement and improvement from the costly experiment. It will frequently be found possible to fire at rocks of known dimensions with targets marked upon them where practicable. Large screen targets can be constructed of boards and placed on reefs or sand-spits, or on piles driven in shallow water. For squadron exercises such targets should always be constructed. A very small percentage of the cost of the ammunition wasted in wild or unrecorded firing would pay for targets that would make these exercises practically significant and permanently instructive.

For sea or floating targets there should be a raft supporting a canvas target with its base an equilateral triangle and its three vertical sides six feet high by twelve feet long. For combined practice it should be marked by a black belt one foot in width, and vertical stripes at the corners and in the middle of the sides. For experimental practice with rapid-firing and machine guns, it might be painted a neutral color, to represent a torpedo boat. The actual work of framing, rigging, and mooring such a target would form a useful seamanship exercise for junior officers and boats' crews. Such

targets would be adapted to practice while drifting in a tideway, and should be capable of standing upright in a moderate seaway.

No one who has noted the effect of a spirited and successful target practice on the crews and divisions which have made good shooting will be disposed to allow such interest to evaporate. Smartness in drill, attention to instruction, and promptness in cleaning brightwork are among the direct and visible results of success in competitive firing. If these are worth cultivating, we must have better targets, and a thorough and intelligible record of practice.

The expression "combined target practice" has been used to indicate the use of the various component parts of the battery to render mutual support. This enables the Hotchkiss guns, with their explosive projectiles, to be used as range-finders, to regulate the fire of the great guns. Volley-firing with rifles and rapid fire with Gatlings may serve the same purpose at short ranges or in smooth water. The regulation of fire from all these weapons must be studied and made the subject of experiment and exercise, to avoid danger and failure in action. Small-arm practice on shore must precede the general exercise of the crew in firing at floating targets, but selected marksmen should always be posted to keep up a well-directed fire in action.

The feature of highest value in combined firing is its likeness to actual fighting. This resemblance should be emphasized and made as real as possible. The same idea should dominate all exercises at general quarters. The nature of the imaginary attack and the force, bearing, and distance of the supposed enemy should be communicated to officers of divisions, and guns should be loaded and laid in anticipation of his movements. General quarters should have the same relation to aiming drill that combined target practice has to divisional rifle-firing.

It may be objected that too much time is required to admit of systematic target practice, either for rifles or great guns. This can hardly be the case while steamers are sent to sea to cruise for a week or more, with light breezes, in summer. The difficulty seems to lie in some distorted comprehension of the relative importance of different exercises. Opportunities for drills and exercises of vital interest are passed by because a slight interruption of the prescribed squadron routine would be involved. Ships must be allowed time and coal for careful and rational target practice with their batteries. They must not be allowed to fire away

their allowance in desultory or perfunctory practice, when there are hundreds of outlying rocks which might serve to give sound training to their gun captains and furnish data for the solution of vexed questions in modern naval artillery. If ranges on shore can be found within the limits of a station, ships must be sent there at least once a year to complete a certain amount of target practice—say 50 rounds per man. If time is limited, other exercises must be suspended and routine must be modified or temporarily sacrificed to more practical requirements.

Similar considerations will certainly impair the standing of such exercises as single-sticks and pistol drill as essential parts of the routine of a ship carrying magazine rifles and rapid-firing guns. We must choose our part, and we must yield to the tendencies of our age. These weapons are obsolete for general use, and exercises with them are abortive and fantastic. It may be said that broadsword fencing is a good exercise for the muscles and develops a fighting spirit among the men. If this were true, it would deserve as much recognition as we now give to boxing, and no more. But practical experience convinces me that our routine single-stick exercises develop no interest or instinct whatever among seamen. Ten years' drill does not secure any actual progress. For the revolver, it is sufficient to say that "it does not develop in practice the advantages claimed for that kind of arm." For once we can agree with the Ordnance Instructions of our youth.

Those drills which have been rejected here will hardly reappear when we come to consider methods of preparation for detached service. Substitutes for them will be suggested, and it is thought that all the advantages claimed for them may be attained without consuming the time and energy of instructors and ships' companies in exercises which have no direct practical value or significance.

The special duties of those divisions which are not stationed at the guns are evidently the same as those now assigned to the navigator's division. Their instruction should be revised and advanced far enough to recognize the existence of the screw propeller, water-tight compartments, and other modern improvements. Leaving all repairs of spars and rigging to be executed at leisure, and giving up their futile stoppers and fishes, they must keep the screw clear, look out for the steering gear, and remove obstructions to the working of the guns. To clear the screw a special grapnel guided by a pole and worked by whips to the gaff and yardarms should be fitted. The

use of sails and mats for stopping leaks must also be made a regular exercise. Water-tight doors must be worked by the engineer's division and ammunition passers on lower decks.

This last class must be carefully stationed and drilled. To prevent confusion, projectiles and charges may be checked by attaching metal tags showing the division for which they are destined, and the weight of the shell or powder sent up. These checks should be used at all general exercises without ammunition, and should be rigorously accounted for when firing takes place. Any blundering or tampering with the checks should be punished severely. This expedient will, it is thought, secure better results than are attained by the present straggling arrangement of the powder division.

V.—Training Men for Detached Service.

The requirements of detached service have been touched upon in treating of complement and organization. It has been claimed that a ship should carry men enough to land an effective force without sacrificing her powers of defense or navigation. The organization of equal and interchangeable divisions has had this purpose in view. The distribution of trained men of all classes, from carpenters to cooks, is necessary for the complete efficiency of detachments. There should be a quartermaster or signalman in each landing company or group of boats, as well as officers' servants and berth-deck cooks to look out for messes. The assignment to regular messes should be by divisions, with the exception of petty officers and servants, who may be otherwise provided for. Boats' crews should be assigned on the same basis, and boats should be grouped under the control of divisional commanders.

Instruction should be adapted to organization, and should go as far as possible with each man. The untrained and ineffective forces which now make up the bulk of the powder division may hardly be advanced beyond elementary rifle practice, which should also be the only military training required from the engineer's force. For the remaining portion of the crew progressive training must be the rule; differentiating according to individual capacities.

The principal weapons with which men must be trained for detached service on shore or in boats are, in the order of importance and frequency of use, as follows:

1.—Magazine rifles. Taking the Spencer-Lee as the accepted

type, each man should carry 60 to 80 rounds in the loops, and four filled, detachable magazines in light pockets inside his woven cartridge belt in front. Reduced amounts may be carried for practice or special service. Reserve ammunition in boxes strapped for slinging and carrying may also be supplied. Light bayonets may be carried in leather buckets like the sling cases of a telescope, to be served out and fixed on landing or boarding.

2.—Light, rifle-calibre machine guns or single-barrel, rapid-firing shell guns. The former have some advantages for use on shore, but their continuous fire gives poor results in boats. Light field carriages capable of quick train should be fitted to carry a liberal supply of ammunition.

3.—Light or heavy rifled howitzers for special services, such as attacking an enemy sheltered by brick or stone walls or houses or intrenched among rocks. These, and their obsolete companion the smooth-bore bronze howitzer, appear to be considered as the special arm of seamen on shore. They are massed in battalions and trundled through the streets of our cities on all ceremonial occasions, in spite of their awkwardness and ineffectiveness for display or service in the field.

The persistent favor shown to these last-named weapons compels an inquiry into their real value. In the first place, they are almost useless against troops in extended order or under natural cover or that furnished by earthworks. Neither the attack nor the defense of Plevna was able to employ artillery with effect. In the next place, the development of rifle fire exposes the gun detachments to many dangers, due in part to their slowness of movement and the massing of men at the drag-ropes. The range of small-arms is quite equal to that of most naval howitzers, and the accuracy much greater. The scanty supply of ammunition is also a source of weakness. The employment of perpendicular or high-angle fire would seem to give machine guns and small-arms such a decided advantage over howitzers as to involve their withdrawal from all field movements. Two facts noted with reference to European field artillery tactics support this view. All field movements in action are supposed to be conducted with the horses at a gallop from the instant of limbering up, and guns are not to be brought into action without infantry supports deployed at least 600 yards in advance.

These considerations seem to forbid the subordination of all landing organization to the awkward necessities of field artillery without

horses or limbers. When landed for battering houses or walls, howitzers should be worked by one relief, supported by the remainder of the division. Bayonets should not be carried by the men at the drag, and their load of rifle ammunition should be reduced. The same arrangements should be made for working such machine guns as may be landed. Higher numbers may carry revolvers at the guns instead of rifles. Being trained men, these numbers will readily learn to load and fire revolvers without making that one of the routine divisional drills.

Accuracy of fire with all these weapons is essential to the preparation of ships for naval actions, and a system of aiming drill and target practice has been elaborated with that end in view. Few changes will be necessary to make the same methods apply to service on shore. Firing from a rest must be encouraged in boats and on board ship, but men must not be allowed to depend upon finding rests while on shore. Judging distance must be taught under various circumstances at every opportunity, especially while on shore.

While complete divisions may be landed for drill and firing or detached for special service, it may be best to combine them in pairs for the permanent battalion organization for parades and distant service. A company of 72 men, with three officers, would be formed by leaving out the reserve men or ammunition passers from each division and alternate division commanders. These men should serve as boat-keepers and shipkeepers in port, and, with the assistance of a complete division, should suffice for the safe navigation of the ship and her defense against attacks by an inferior force. This disturbance of the relation between an officer and his division is suggested with reluctance as a means of detaching a full fighting force without crippling the cruising power of the ship. The two division officers should alternate in drilling the combined company at battalion parades, and each should drill his own division at other times.

In teaching sailors to drill as infantry, we must not waste time on superfluous movements, or in attempting to secure mechanical precision with the manual, or in wheeling. It sometimes seems as though the marine guards of our ships partially counteract their undeniable usefulness in other respects by offering an example of rigidity in marching which is as much out of place on a ship's deck as it would be on a field of battle. While we must teach position and marching carefully, to correct the defects incident to a seafaring life, we must not attempt to imitate the Marine Corps or the crack regiments of the

National Guard. We may even be compelled to look abroad for practical military models, as well as for the tactical instruction which we need to fill out the bare framework of our accepted drill-books. It is well to know the exact position of each marker and guide in all evolutions, but it is also necessary occasionally to assume the possible presence of an enemy, and regulate our formations and marching with some regard to his position. There must be something to learn, to bridge the gap between the manual which usurps the name of Tactics and the formidable technicalities of military strategy. The methods of training infantry used in the German army, as described in various papers in the proceedings of the Royal United Service Institution, seem to furnish the information required.

On board ship we can only teach simple methods of passing from line to column and the reverse. Skirmish drill can be taught to small detachments, and the use of cover, advancing by rushes, and other practical matters, can only be taught on the rare occasions when the battalion is landed. These subjects, with a very few movements in company front, are all that can be allowed to interfere with the effort to teach the men to march steadily and without fatigue. Reasonably rough ground should be preferred for these exercises, instead of the streets and squares usually selected. Dress parades should be rare indulgences either on shore or aboard ship, but they should not be altogether cut off. A band and a crowd of spectators will often render much aid in developing military instincts among sailors.

Skirmish drills on shore should always be based upon the idea of an attack on an enemy's position, which should be marked by flags or by targets for field-firing. These arrangements should be made beforehand, and company officers should reconnoitre the ground before the companies land. Blank cartridge may be used to give more steadiness in firing, and ball cartridge for field-firing at targets posted to represent an enemy's force. This would serve to teach men to judge distances as in actual warfare, and to seek cover in advancing. Trained marksmen should be told off to estimate distance and fire trial shots. These exercises may be carried on independently by companies or by the battalion, skirmishing by numbers in the latter case.

In preparing to land the battalion, the equipment should be by companies rather than by boats. Men must carry their supplies, and they can be distributed with less confusion on board ship than on the beach or in the boats. Battalion formations should frequently

terminate with the actual embarkation of companies in their proper groups of boats.

It is impossible to make fixed rules for the equipment of boats for any particular service with the idea of showing them all off together in five minutes or in half an hour. Actual requirements must govern the outfit for each case. The new ration should be able to furnish provisions in convenient packages, and the distribution of men by messes should secure the supply of mess gear for each detachment, with a cook to each boat to look out for it. The arrangements for feeding men on shore must be tested from time to time by actually giving men one or two meals on shore or away in boats. Soup or coffee could be carried in mess-kettles and the dry part of the ration in haversacks for a single day's absence. Such tests are necessary if our outfit of boats is to be anything more than a sorry farce.

As a means of carrying out such tests and giving practical military instruction, divisions or companies should be landed to camp out for a day or more in suitable positions. Forty-eight hours spent in camp in this way would give more time for deliberate target practice, skirmishing, sham fights, etc., than can be utilized in a year's cruise where men must return to the ship for meals.

It would also furnish much-needed variety and recreation, and would be preferred to the ordinary "rough liberty" for twenty-four hours by the best elements in our ships' companies. Of course climate must be carefully considered and hygienic precautions strictly enforced under the supervision of a medical officer. Discipline should also be secured by proper orders and properly posted guards, who should be held to a strict military responsibility.

This recommendation may meet with objections based on other grounds than discipline and hygiene. It may be urged that division officers cannot be spared without interfering with the harbor watch, or that men cannot be spared without interrupting. It is sufficient to say that all these difficulties must be encountered and overcome in actual practice. Landing an efficient naval battalion is often the only means by which bloodshed can be averted or the honor of the flag vindicated. The events which followed the bombardment of Alexandria will illustrate this statement. No mechanical routine and no traditional precautions should prevent the practical training of an efficient organization for landing.

Combined boat exercises should be simplified both in regard to outfit and evolutions. Not much can be learned by officers or men

by going through the complicated, rectangular manœuvres of the signal-book. In action they would be as useless for boats as for ships. For landing men only two or three evolutions are necessary, and speed in pulling is more important than accurate dressing in line. Pulling-boats should never lie on their oars under fire, and should not carry guns with any view of firing while making an attack. Rapid-firing guns in swift steam launches are the only weapons which boats can use against an enemy armed with modern weapons. Gunboats must do their part in keeping back the enemy, or landing in the face of an enemy will be found impracticable.

The real use of combined boat exercises seems to lie in affording opportunities for training crews in pulling or sailing in competition with others. Divisional boat exercises are necessary to prepare them for such competitions, as well as for a variety of essential military uses. Boat racing should be encouraged and extended so that nine-tenths of a ship's company will not be restricted to betting or boasting as their only part in the sport and exercise.

For military duties, as guard or picket boats, steam launches must be used as far as possible. Pulling-boats may be armed and assigned posts to complete a cordon, but launches must be relied upon for the active work. Divisional boat exercises should be directed to training relief crews for torpedo boats, guard boats and torpedo catchers. Every modern cruiser should have one real torpedo boat of high speed and one handy and seaworthy steam-cutter for towing and guard duty. Neither class of boats should be assigned places to manœuvre in line with pulling-boats, but should always act independently. Unwieldy passenger steam launches should not be carried by men-of-war. Ships should be ready to furnish relief crews for torpedo boats of all classes which may be in use in the service.

The control of all exercises, which will remain with the captain and executive, may be most judiciously exercised by frequent inquiry and inspection, to ascertain results and comparative progress. Uniformity of method is of less practical importance. Any division officer who desires to carry on a special drill of unusual length should state his plans to the executive at least twenty-four hours in advance, in order to get permission to keep the men. The navigator, being relieved from all care of a division, should inspect all ordnance material regularly and take the deck during drills, as at present. He should receive full reports in regard to the drills of each division, and should keep a full register of drills for the inspection of the captain. This record should con-

tain the character of each drill, the time occupied, the number of men present and excused, and such remarks, records of times, etc., as may be appended in explanation. A summary of the drill register might be sent in as a quarterly report, copies being retained on board for presentation at general inspection. It should not be the object of such comparison to secure exact compliance with any arbitrary routine, but rather to make sure that a reasonable amount of practical instruction has been given.

VI.—Conclusion.

This paper must be brought to a close without any attempt to summarize its arguments or suggestions in detail. Among the specific recommendations which may be noted are the following:

1. Complements as large as berthing accommodations will allow.
2. Divisions equal in force and efficiency. The number of divisions to regulate the detail of line officers.
3. Physical training and preparation for service as the objects of seamanship drills.
4. Regular watch drills in port and at sea.
5. Competition to be directed to finished results, including changes of rig for different kinds of service.
6. Gun divisions stationed in two reliefs, with sets of ammunition passers.
7. Aiming drill and target practice as the principal exercises, with all arms retained in the service.
8. Magazine rifles and machine guns to be the ordinary arms for all forces sent on detached service.
9. Exercises on shore to include camping, field-firing, and skirmishing over rough ground.
10. Boats, especially steam launches, to be prepared for special service by varied methods of equipment and exercise.

The accompanying arguments may be found unnecessarily discursive and aggressive, and the suggested details of various or uncertain value. The problems of naval reorganization and reform are too large and too intricate to be solved by any individual expression of opinion. Suggestions, rather than solutions, are set forth in this essay. The writer may have failed in formulating opinions which will stand the test of time or the criticism of his brother officers. From such failures not even official programmes are exempt, and this paper assumes to be nothing more than a personal contribution to the discussion of a professional question.

If charged with the atrocious crime of being in earnest, the writer will hardly be able to offer a general denial. It would have been easy enough to keep within the limits of superficial safety by adhering to accepted methods and elaborating comfortable commonplaces. It has been thought right to make explicit and radical suggestions of change at the risk of giving advantages to whatever opposition may be provoked by the obviously and necessarily critical form and manner of this paper. Active and earnest discussion must prepare the service at large for important changes of routine. Without such discussion, the systems devised by boards or bureaus will fail to be accepted or assimilated in practice. If the Naval Institute succeeds in stimulating this discussion, it will confer a great benefit to the future of the Navy.

The leading novelties which have been presented are, in nearly every instance, in practical operation in foreign services. This does not guarantee anything except their practicability under certain conditions, nor is it urged as a final argument for their adoption in our own service. The principal labor in writing this paper has been in selecting and adapting such measures as appeared to be best suited to the peculiar conditions existing in the Navy of the United States.

There has been no intention of laying down an absolute and inflexible routine for all ships of modern type. Such an attempt would involve a disregard of the facts and tendencies of recent naval progress. Until these tendencies become fixed in direction, drill and organization must be more or less experimental. Individual responsibility must be encouraged to assist the development of higher forms of discipline and efficiency. Absolute uniformity of method is bound to check the process of evolution. Comparison of results must be substituted for exact control of methods to secure progressive improvement. There is little danger that such a change will produce a greater variety in standards of efficiency than is now brought about by laxity and lack of interest in regard to warlike contingencies.

The training of officers for command must always be recognized as an object of organization and drill. The development of individual responsibility is an indispensable factor here. Officers must learn to decide questions arising during exercises according to their own judgment within certain limits. The instinct of subordination must not be cultivated at the expense of responsibility and habits of decision. The chief object of professional education is not to teach

officers to take exaggerated precautions against imaginary dangers, but rather to prepare them to accept necessary risks with coolness and confidence in their actual resources and in themselves.

It has not been found practicable to suggest changes without making those incessant comparisons which are apt to be considered the most odious forms of criticism. Unless we can say with full conviction, "The old is better," we are bound to criticise and compare, to eliminate the obsolete from our established methods. This attitude is not inconsistent with respect for constituted authorities or for the experience of the past.

Those who share with the writer the conviction that we need to transform the methods as well as to renew the material of our Navy, may sympathize with the purposes of this paper without accepting his conclusions. In spite of the reactionary routine which we are compelled to practise in our ships, and the traditional theories which we are expected to recite on examination for promotion, there are some believers in naval progress who cannot help standing up, like Galileo after his recantation, to say of our little world, "It moves for all that." This essay ventures to assert this principle of inevitable progress and to attempt its application to the details of organization and exercise for modern men-of-war.

APPENDIX.

SAMPLE ROUTINE.—PORT.

May to November.

4.30. All hands. Hammocks, 15 minutes; coffee, 15 minutes.
5.00. Turn to. Scrub clothes, 30 minutes (clothes soaked in fresh water overnight).
5.30. *Starboard watch* scrub spar-deck, ladders, etc., 1 hour.
Port watch clamp down gun deck or superstructure with hot water, 40 minutes. Bathe, 20 minutes. *Watches to alternate.*
6.30. *Port watch*, seamanship drill and squaring yards, 30 minutes.
Starboard watch bathe, 20 minutes.
6.50. Spread mess-gear.
7.00. Breakfast.
7.30. Shift into uniform of the day.
7.45. Turn to. Spread awnings, roll back hammock cloths, etc., 15 minutes.
8.00. Colors, lower boats. Clean gun brightwork, 30 minutes.
8.30. Clean deck brightwork and sweep down.
9.00. Quarters. Inspection of armament, 15 minutes.

9.30. *1st drill call*, 2 *divisions great guns.* Stations and pointing, 30 minutes.
2 *divisions infantry drill.* Aiming and squad drill, 30 minutes. Company drill, 30 minutes.

10.30. *2d drill call*, *great guns*, *infantry drill*, } as above. Divisions alternating.

11.30. Sweep down.

11.45. Spread mess-gear.

12.00. Dinner.

1.00. Turn to. Sweep down.

1.30. *3d drill call.* Boats. Torpedo instruction or skirmish drill, 1 hour (Monday, Tuesday, Thursday, Friday).

3.30. Pipe down scrubbed clothing. Sweep down.

4.30. Muster starboard watch at stations for next morning's exercise.

5.30. Supper.

Half an hour before sunset, spar drill for all hands.

WEEKLY ROUTINE OF GENERAL EXERCISES.

Monday.—General quarters, 9.30 to 10.30 A. M.

Wednesday.—Sail or spar drill, or combined boat exercise, 9.30 to 11.30.

Thursday.—Battalion drill. Equip for landing, 10.30 to 11.30.

NOTE.—In winter, no exercise should be held before 9 or after 4. At sea only one drill call should be sounded; watch drills at 11 A. M. and 3 P. M. being substituted for divisional exercises.

DISCUSSION.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MAY 12, 1886.

Captain N. H. FARQUHAR, U. S. N., in the Chair.

Commander H. C. TAYLOR.—*Mr. Chairman and Gentlemen:*—There seems to be but slight opening for any save favorable criticism in the suggestions of the essayist. It occurred to me, before reading this excellent essay, that the question proposed was difficult on account of its vagueness; for what are "our war ships of latest type"? If such painful doubt has presented itself to the essayist, he has skilfully set it aside by suggesting changes which are very valuable for war ships of either old or new types.

He strikes boldly one of the keynotes of our defects when he says that we prepare only for "little wars peculiar to colonizing nations." It is indeed true that we prepare only odds and ends of a fleet, when a complete naval force would cost but little more in the long run than these present odds and ends.

The suggestion that a proper relation between the number of officers and the fighting force of each ship be established and maintained, is a most valuable one. I think it an excellent plan also that all commissioned officers should have deck duty in port; nor do I believe that the plan of keeping harbor night watches in a pilot house would meet with such vigorous opposition as the essayist fears.

The protests against superficial and showy drilling deserve the careful attention of all officers. Especially true and worthy of consideration also are the essayist's remarks upon handling steamers as a warlike exercise, and his statement that the problems of handling modern ships under steam are as varied as in the days of sail power. At this point, however, I fail to perceive that the most important element of success is dwelt upon by the essayist. I refer to that familiarity with the open sea which comes from training constantly at sea. If we can have steam cruisers and steam training ships kept as long at sea as the sailing ships, then I see clearly that the steamer practice is the more valuable, and can agree with the essayist that our present training squadron is obsolete. But so long as steamer training is confined principally to sheltered waters, and a cruiser waits for weeks to get a smooth day outside for target practice; so long as we permit the approach of bad weather rudely to interrupt sea manœuvres, while we make speed for the nearest harbor; so long, in fact, as we avoid the persistent sea drilling which is absolutely necessary to successful sea fighting—then, for just that length of time our present training squadron is not obsolete; and everything that is learned by a steamer's crew about a new ship, engine, or gun in the quiet waters of Chesapeake or Narragansett Bays, is more than balanced by that unconscious acquiring of the *sea-habit* by the crews and officers of those old sailing ships. When steamers will drop targets over in bad weather, cast loose their batteries in a half gale of wind, learn their

tactical diameters with a heavy sea running, find out practically how much sternway their ships will stand in such weather; when they will practise ramming and work their torpedoes and machine guns with a topping swell on; when, in fine, they will *use* on the open ocean the tools meant for ocean fighting, and do this habitually as their every-day navy work—then, and not till then, will the usefulness of our old sailing ships have passed away.

Turning to other portions of the essay, I note that the present loose system of powder divisions has been thoroughly grasped by the essayist, and believe that much good may result from his instructive suggestions concerning it, and concerning the defects in our present methods of target practice.

To touch upon all the good points of this interesting essay would occupy unduly the time of the Institute, but I would ask permission to notice one statement which seems to me unsupported by the evidence. The essayist refers to boarding as an improbable event in the future.

Now, if ramming is to be attempted in fleet engagements, as is quite certain to be the case, it must often happen that ships will find themselves, whether they wish it or not, alongside of enemy's ships. Efforts to ram, and efforts to meet or avoid the blow, must frequently produce this result; and in such a situation I do not see what other course than boarding or being boarded is open to us. It seems to me that our crew would suffer less from the enemy's machine-gun fire, if they were on the enemy's deck engaged in a general *mêlée* with his people, than if they remained on board our own ship. Do away with swords and pistols, if desirable; replace them with bayonets and magazine rifles, if they are better; but not because boarding is obsolete, for few things seem more certain than that boarding is to be a marked feature in fleet engagements of the future. It played a great part in the galley period, and became less prominent when sailing ships came in and ramming was not practicable. Now, under steam, we revert in many ways to the tactics of the galleys. Ramming will again be known, and boarding as its inevitable consequent.

Commander HORACE ELMER.—*Mr. Chairman and Gentlemen:*—Since first the subject of the present prize essay was proposed by the Board of Control, I have looked forward with interest to the result. The subject seemed to me not only important, but timely. It was fair to assume it would be published, with the accompanying discussion, by the time the new cruisers were ready to be commissioned. It was a practical subject, calling for a practical solution, and it was thought that such an expression of the views of the service at large might be of some value to the fortunate few who are to have the privilege of organizing and drilling the first of our new cruisers.

That the subject was proposed by the Board of Control would indicate that the necessity for change was recognized, and it hardly seems necessary for the essayist to have devoted so much time and space to prove this fact.

There is much in the essay that seems to me admirable—many valuable suggestions, many things very well said, and some others, perhaps, that might as well have been left unsaid. But, with all its details, sometimes very minute in matters of drill and routine, I think the commander and executive officer of the Atlanta will not obtain from this essay any very great assistance in their

labor of organization. That the division should be the basis of organization I believe, and agree with the essayist thoroughly; but with that statement, though frequently repeated, he virtually stops. To make such a change effective, far more radical changes will be necessary than merely messing the crew by divisions. The present system of parts of the ship must be given up; the number, title, duties, and character of petty officers changed; the gun captain should become the standard of selection, not the accident, as heretofore. All these questions will meet one who attempts to organize a ship's company on the basis of the division, and it seems to me they are more to the point than discussing the advisability of calling all hands to send down royal yards, when none of the new cruisers will have royal yards; and, whatever may be their "feeling of toleration" for the old drills, I have no idea the officers of the deck of the new cruisers will spend many of their leisure hours in light breezes, tacking or even chapelling ship. Therefore, it seems to me that all this onslaught upon certain forms of seamanship drills, necessarily obsolete in the new cruisers, is wasted ammunition, and I feel sure the essayist will find, throughout the service at large, far more general agreement than he seems willing to admit with the principle that all drills should be established with a practical purpose in view.

With the one important change in the detail of organization advocated in the essay, the abolition of the powder division, I do not agree. An improvement in the character of the powder division is certainly desirable, but it seems to me that in the future this division will be of much more importance than in the past. All the larger of the new cruisers should have, and probably will have, an ordnance officer, having special charge of the ordnance, ordnance stores, torpedoes, and electrical apparatus. This officer, in my opinion, should have charge of the powder division. The stowage, care, and delivery of ammunition are matters of the first importance, and should be under the charge of one competent, responsible officer. Were it practicable to have separate magazines, shell-rooms, and percussion lockers for each division, the scheme proposed by the essayist would have strong argument in its favor; but, by looking at their plans, it is evident the new cruisers have not been arranged with any such scheme in view. I have made these remarks with no desire to be captious, but because, though in some matters of drill the essayist has gone largely into details, in the more important matter of organization he has, in my opinion, but skimmed the surface, and the question as proposed by the Institute still remains, in its more important part, unanswered.

Lieutenant R. R. INGERSOLL.—*Mr. Chairman and Gentlemen:*—That the Prize Essay for 1886 is a very comprehensive and able paper, I think can hardly be questioned. That the changes proposed are a necessity, because of the introduction of new-type ships, is, however, not very clear. The suggestions will apply, with few exceptions, with equal force to our old ships, of whatever type. This should perhaps be a matter for congratulation, rather than for complaint, since nearly every feature of the scheme may be adopted at the pleasure of commanding officers—if, indeed, very many of them are not already being carried out—and our old ships can be modern in organization and drill, if not

in other matters. I think no one will dispute the general spirit of the essay, —that all organization and drill should be carried out with a view to possible emergencies of weather or battle, with a definite standard of excellence to attain, and that all other exercises should be subordinated to those which have these definite objects in sight. There may be many of us who believe that the present system of organization and drills has been carried out with a view to possible contingencies so far as obsolete material will permit, but it will probably do us no harm to agree that the definite objects should be kept more distinctly in view in the future than perhaps they have been in the past.

It is to be regretted that in his scheme the essayist has not told us what relation his quarter bill bears to the watch bill, since he does not change the latter. What shall be done with the large class of men not now assigned to gun divisions, and known as idlers? What should be done by a modern man-of-war in clearing for action, and what preparations should be made to avoid the consequences of ramming or collision?

The scheme for drills offers but little for criticism and much for commendation, especially the suggestions in regard to aiming drills and target practice, which are excellent. No definite system of recording great-gun target practice has been recommended, however, and while the essayist dwells upon the importance of keeping such records, he does not enlighten us as to the method of scoring or of plotting the fall of the shot. The plan of observing the fall of such shot by two observers having given very good results at the Naval Academy and elsewhere, I think, for want of a better plan, that could be used with benefit.

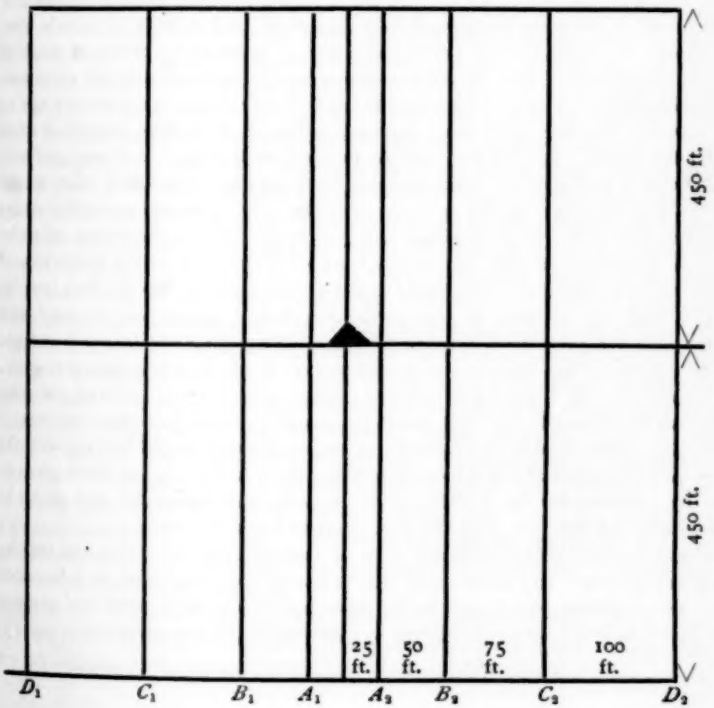
I understand the object of this discussion to be to bring out all the points possible, as well as to talk of the features that the essayist has advanced. With this understanding, then, I venture to suggest the following as a scheme for determining the size of diagrams for scoring target practice at any range and for any arm. It is perhaps unnecessary to say just here that target practice without plotting the shot and a study of the diagrams made is a waste of public money.

I assume, first, that the normal target for high-powered great-guns should be a ship 300 feet long, 50 feet beam and 20 feet above the water line, and at a distance at which guns of the sort we have in mind would be used in a naval action with a probability of many shot hitting; and I assume, further, this distance to be 2000 yards. When we have accumulated sufficient data from the firing of high-powered guns, this distance may be modified. Now, it is not practicable to have a vertical target 300 feet long by 20 feet high, so all we need is a small target, yet of sufficient size to be seen clearly at the range used, if we suppose it to be placed at the centre of the ship at the water line. In plotting the fall of the shot around this target, no positive value should be given in the score to a shot that would not hit the ship, so we have a maximum lateral limit to the target diagram, or 150 feet each side of the target. The ship, when end on, presents a minimum target, so the lateral limit for which maximum values can be given is fixed—viz., the half breadth of the ship, 25 feet on each side of the target. Take points half way between the target and maximum limits, or 75 feet, for the limits for which one-half the maximum value

can be allowed. For the dimension of the diagram in the other direction, I think first it should be taken on the horizontal plane, because a better comparison is afforded and less labor is required, a very small error on the vertical plane becoming large with high-powered guns on the horizontal plane.

The limits of the target diagram, then, on the horizontal plane should be the overestimate and underestimate that can be made with a high-powered gun when the true range is 2000 yards and still hit the target at some point of its height. These, in the case we are considering, and when the gun is aimed at a point its own height on the vertical target, say 10 feet high, will not be less than 150 yards; so our target diagrams for plotting target practice should allow for an error in range over and short of the target of at least 150 yards. For shorter ranges the lateral dimensions of the diagram should be diminished proportionally to the range, but the dimensions for range should not be changed, because with flat trajectories the errors in range for the same error in sighting rather increase than diminish as the range is diminished.

Let any value, say 20, be given to shot which fall within the lines which represent the ship end on; within the next lines 10; and the minimum value 5; then have a space 100 feet wide within which zero would be given; then give negative values to shot which fall without according to a fixed scale. The diagram would be like the following:



Hotchkiss guns should be judged by scoring on target diagrams representing the dimensions of the objects against which they will be used, such as torpedo boats 120 feet long by 12 feet beam, etc. Certain errors in gunnery practice belong to the gun alone and not to the gun captain. These could be ascertained at proving grounds, and should form a part of every range table. It is evident that the minimum dimensions within which shot plotted should have the maximum value should not be less than the errors due to the gun alone in range and direction. Practice at speed can be plotted and scored without serious error, provided the fire is delivered when the ship is near a line joining one of the observers and the target; this will require more time for practice, so that it can be plotted on rectangular diagrams, but it is believed that such diagrams better represent the effective work of the gun than when circles are used.

I think the sea or floating target recommended by the essayist is not a good one, for the reasons that if it is intended to be large enough to show the effect of firing against ships, or to encourage the men by showing a large number of hits, that it is not large enough, and it is so large in another sense that it is very unhandy. I think the target used by the Standish for three years past is the best I have seen for the purpose for which a target should be used; that is to say, to represent a point at which to aim and large enough to be clearly seen at all distances for which we need to use it. The Standish target consists of a float made of a square framework with diagonals, and is built of 4-inch pine scantling; the sides are eight feet, and a step is fitted at the centre of the float for the target pole. The target has four wings of *black* muslin, the same size as the regulation target. This target is simply hove overboard from the rail of the steamer, and has never once capsized, although it is often launched when going full speed. It does not require weights or barrels. It floats perfectly upright in a half gale of wind, and can be seen when smoke or haze would render a white target nearly or quite invisible. The expense attending target practice with service ammunition will probably result in the fitting of some sort of apparatus in the axis of the bore of large guns to fire Hotchkiss or small-arm ammunition. A reduced target to represent a ship 300 feet long by 20 feet high, at a distanee of 2000 yards, if a vertical target must be used, at a distance of 100 yards from the gun, would be fifteen feet long by one foot high. If the gun sights are used, it will not be so easy to hit as at first sight may seem, and if the records of each gun and gun captain are kept and studied, valuable data can be obtained even with small-arm ammunition, and at small expense.

Copies of the records of all great-gun target practice should be kept with the ship, as they would afford the commanding officer knowledge of what his guns and gun captains can do at different ranges, and such knowledge will go far in influencing his decision as to the best range to begin an action.

The perfection of details of any plan of organization and drills can only be obtained by trial; and while many details would seem desirable in connection with so comprehensive a plan as we have before us, yet I think the essayist has given us much food for thought in those which he has submitted.

Lieutenant D. H. MAHAN.—*Mr. Chairman and Gentlemen:*—While I have listened with great interest to Lieutenant Calkins' paper, I must say that I think he does not go far enough into the matter, and I think his changes in organization and drill can be improved upon. One of the principal faults of our present system seems to be that a man has too much to remember. There is no system of association—that is, there is no attention paid to the simplifying of the work by causing one position to have a direct bearing upon other positions in drill. We station a man around according to the fancy of the executive officer. A man may be in the first division, third cutter, second howitzer's crew, and in the launch at "abandon ship."

I would suggest that two organizations be allowed, and no more—one to be known as the fighting organization, the other as the seamanship organization. The first to comprise under its heading the company, division, boats, artillery, and, as it has boats then, of course "abandon ship"; the second to have all the evolutions connected with the handling of the ship, its spars, and sails. As soon as the ship is cleared for action, then the seamanship organization ends and the fighting organization goes into effect.

Take the company as the basis of the fighting organization; the company to consist of forty-eight men and four sergeants. Allow four companies to a first-rate, three to a second, two to a third, and one to a fourth. Lieutenant Calkins needs only forty-five men to his divisions, so seven extra men will not be amiss. These companies should be put on board as the fighting complement of the ship, and should not include any non-combatants. Divide the company into two platoons for artillery drill, two pieces of artillery to each company: thus, you can drill them as infantry, artillery, or as both. Put this one company into two cutters, to be known as first cutters starboard and port. At boat exercise you will have a company in two boats, a platoon in one boat, and a piece in each boat if necessary. Have this company to form the first division for ship-fighting. This division would then have sixteen ammunition passers instead of nine—none too many. The divisions should be arranged on board ship as companies are arranged in battalion—in other words, having four divisions, a senior forward, then a junior, next a junior, and a senior aft. It must be remembered that the captain, executive officer, and navigator are going to have as much as they can attend to now. So forward and aft should be the proper positions for the seniors. I would station the men so that a man in the first platoon of the first company would be in the first artillery crew, first cutter starboard, and first division; and, still more to render his memory less burdened, I would have the first set of fours as the first set forward on the drag-rope, first set forward in pulling boats, and filling the first places at great-guns, so that a man will associate No. 1 front rank, first set of fours, with No. 1 at piece, No. 1 in boat, and what is now first loader at gun. The men will thus be continually working together, will become accustomed to each other, work better, and more quickly become accustomed to their places.

As Lieutenant Calkins suggests, it is desirable to have the ammunition passers belong to the different divisions. The powder division should consist only of the men stationed in the magazines and shell rooms. Now that ammunition

passing has become the most important work of all, we no longer want Chinese, bandsmen, and ignorant servants to control the supply of ammunition.

Outside of the fighting organizations we find quartermasters, coxswains, berth-deck cooks, messmen, idlers, and engineers' force. It would be well to reorganize the petty officers. Make them a distinct set, and so separate them from the rest of the ship's company as to give them positions and authority such as sergeants and corporals have now in the Army. There should be two distinct sets of petty officers, with two grades of pay, and they should have a different uniform from the men, and at the same time not so different as to render them too conspicuous in action. They should be appointed by a board of officers, and only be disrated by sentence of a court-martial. In the first grade should be quartermasters, quarter-gunners, and coxswains; in the second grade boatswain's mates, captains of parts of ship, ship's cook, ship's corporal, etc. The quartermasters should be young men, intelligent and quick. Coxswains should be chosen from the intelligent men of the ship's company, and should be a sort of acting quartermaster, having charge of boats to which they may be assigned, and of the ammunition passers in their divisions under the officer of the division to which their boats belong. At boat drill, have a coxswain with two boat-keepers in each boat, to look out for the boats when the battalion lands. In the seamanship organization, these coxswains should look out for the rigging and gear on deck. Quarter-gunners should have a complete knowledge of small-arms and mechanical guns, as well as of ammunition. The boatswain's mate, and captains of parts of ship are placed in the second grade, as they do not now require so high a degree of intellect as those selected for the first grade. Berth-deck cooks should be shipped for the purpose; have charge of berth deck and around galley, hoist coal, pump water, etc. There are altogether too many idlers on board ship, and they are all too well paid for the duties rendered. The engineers' force, besides their regular duties, should be instructed in small-arm, Gatling, and Hotchkiss guns, so that they could assist in defending the ship during the absence of the landing party. The firemen should rank with seamen of the first rate and seamen of the second rate. There is no reason why the inequality of pay should exist amongst this set, although it may unjustly exist amongst the junior officers. The only seamen of the third rate on board the ship should be messmen, coal heavers, and berth-deck cooks; so we have seamen of the first rate, seamen of the second rate (formerly ordinary-seamen), and seamen of the third rate (formerly landsmen).

To promote this organization, officers ordered to a ship should go to her with the understanding that they are to make the cruise in the ship, not to be transferred to other ships, and only to be relieved from duty by cause of sickness, sentence of court-martial, or by orders from the Department. On an officer being relieved from duty, his place should be filled by one of his own rank and, as nearly as possible, about his own number. Such an arrangement will add to the content of all and give renewed interest in the discipline and efficiency of the whole Navy. Can you not realize why an officer changed from ship to ship, from division to division, soon loses some of his interest in the

work? A change can also be made in the way of duty. Continual walking the deck and keeping spit-kids in line becomes monotonous after many years. In port have an officer of the day in charge of all. To be always ready for a call, allow him to turn in from 10 P. M. to "all hands" in the morning. If you will not let him sleep, let him read and smoke: if you see him smoking you will know he is not asleep. But the one thing above all others that must be done is to clear away favoritism and political influence. So long as these two hold their present power, no organization can be perfected.

Lieutenant BARRY.—*Mr. Chairman and Gentlemen:*—After reading this essay I must confess to a feeling of great disappointment. I fail to see an answer to the question propounded, and upon careful examination, the essay, to me, seems mainly to be made up of words put together like one of Mr. Gladstone's replies when he does not wish to answer the questions of the Opposition. Except the rather vague suggestion that each division should supply its own ammunition, I fail to see a new idea advanced. For years the platitudes herein contained have been subjects of discussion throughout the Navy; and many of the numerous aphorisms easily can be reduced into more platitudes.

As to a practical application of theories. In a professional sense, the Civil War was the greatest misfortune that ever befell our Navy. Without even an elementary knowledge of military comparison, our politicians have been blinded by the results attained, and even to-day, Congressmen apparently sane on other subjects, continually are informing the country that when needed we can create a Navy as we did in 1861! How can we be expected to handle ships properly in actual war, when in peace there is no opportunity afforded for practical exercises? Were it the only definition of seamanship, "handling vessels in fighting condition, that is, under full steam power," would be what we want; but other and contradictory definitions are given elsewhere. Of these later.

As regards naval administration we are between two fires—efficiency and economy. Congress represents the economy, and the Department has to take its cue from the amount of available cash. I know I am talking treason when I whisper against the great efficiency of the Navy; but I venture to say the service would be ten times as efficient if there were money available to pay for extra coal and other expensive items required for practical battle drills; hence, our experimental and practical work is limited: we must cut our coat according to our cloth; though I hope the day never will come again when the captain of a filthy, slouchy ship will be complimented because he had never expended all his "allowances"!

I do not think it was the intention of the question to obtain a theoretical Utopia, but to get an answer showing what can be done for our modern ships and with them. What are these ships of the latest type? The essay fails to tell us. To be sure, the Chicago and Atlanta types are named, but the rest of the paragraph tells us "they are intended to have speed and handiness, and their batteries have been selected and disposed with a view to enable them to choose their distance and to fight without surrendering all the advantages of speed and manœuvring power." This means simply that they belong to the

modern type, and the definition will cover the greater number of foreign naval constructions during the past ten years.

The second part of the question, and the most important part of it, is, What is to be required of them? In fact, this is really the main subject of the discussion. Is there anything in the essay to show the nature of their future duty? To fight, of course. But to fight what? Under what conditions? Where? What to do when not fighting? Are they coast defenders, or so-called line-of-battle ships, or are they cruisers? What kinds of wars are we likely to be engaged in? What kinds of naval operations are these vessels likely to be engaged in? Surely, to use anything "most effectively," it ought to be prepared—first, by finding out what it is intended for; secondly, by adapting the means to the end.

As to seamanship. The essayist defines seamanship "as the art of sailing ships effectively." This, while true of sailing-ships, contradicts the extracted definition first referred to. It is too narrow, and failed to be correct even as early as the second period of nineteenth-century development, when steam became a factor. To-day no commanding officer will allow his vessel to be endangered through failure to get up steam. In time of war, if his engines and boilers are not in a condition to do this, his ship has no business to be out of port. An officer is called a good seaman when he can *handle* a ship effectively under all circumstances, in port or at sea; or, better still (for this is meant by "at sea"), when under way. In a recent discussion of a kindred subject, Commodore Russell defined seamanship as "simply a thorough, ready knowledge of the duties to be performed on board a vessel at sea." Excluding from this gunnery, navigation, steam engineering, and interior economy, no better definition can be asked. It will be seen readily that the seaman of to-day, be he officer or be he man, differs materially from the Benbows and the Tom Coffins of other days.

In any well-regulated ship the development of the strength and activity of the ship's company, with reference to health and discipline, is not dependent upon the presence of spars and sails. In mastless ironclads this can be and is accomplished. The essayist seems to appreciate the absurdity of all this when he says (and to my mind it is the happiest and best hit in the essay) hundreds of men are called on deck to lower three little spars (the royal yards) as the colors are hauled down. This calls to mind the statement, years ago, of an influential officer that at the time defeated the introduction of steam capstans: "When you call 'all hands up anchor,' what are the men to do?"

Without discussing the question of the status of our mercantile marine, I venture to say that, unless vastly improved before our next war, the "traditional naval policy" will find, as it would find to-morrow, nothing in our merchant fleet capable of performing the duties of a man-of-war. Until too late, and when the enemy is thundering at our gates, our traditional parsimonious naval policy, coupled with many other causes, never will permit the use of merchant steamers as proposed; nor, as in England, their special construction. With us this is Utopia, but not feasible.

We next come to the apprentice system. While not properly a subject for

discussion under the question propounded, it seems to me the remedy proposed is worse than the disease. The real cure lies in reward. As continuous-service men, we never get back the very best apprentice graduates. Why? Because they always can find something better to do. This matter was discussed fully in a former prize essay, and needs no further reference. Is (naval) life worth living? Answer it in the affirmative, make it so, and the problem is solved.

Concerning sailors as infantry, it seems to me it would be well entirely to separate sailors from marines. At the very best, seamen never can approach the rigid infantry of Frederick the Great. When a small force is landed, the use of "rigid infantry," as such, manifestly will not be needed; when a large force is landed, enough marines can be gathered together to make up the soldier element; sailors will then devote themselves to skirmish and artillery work—their only efficient work when on shore.

"We need trained men to serve as gun captains, file closers and coxswains"; but what connection is there between a gun captain and a coxswain, or a file closer? I think we can be accused of the worship of the seaman. Practically we say: "A good seaman is good at everything." Let us make gun captains gun shooters, and let coxswains of boats stay with their boats; anybody can be a file closer. What are the requisites for marksmanship? By no means does it follow that a good musket marksman can shoot straight with a cannon. The vital need of our ships and of our future gun captains is target practice. We need a corps of gun captains—men that can take charge of a gun; and we never shall have them so long as we make Tom or Dick "Captain of No. 3" because his watch number puts him there. Gun captains and top captains should have no connection. The principal duty of the latter is to "wash down"; the principal duty of the former is to shoot correctly.

To supply ammunition, the essayist would use the divisions and do away with the powder division proper. If he have a magazine for each gun, the duty of the old powder division will be done by a vastly superior force, and I think less efficiently; if one magazine supply powder, who are to be *in* the magazine? Is there to be one man from each gun, or just enough properly to handle the powder? If metal tags are to be attached to projectiles and to charges, who regulates their number? If a gun be disabled, can other guns make use of the "tallied" charges? Confusion and delay are sure to result. Does not the idea suggest itself that rapidity in the delivery of *projectiles* will remedy all the evil? Powder can always be supplied more rapidly than it can be used, but, with the increase of weight and size, projectiles must be delivered more rapidly at the battery. Increase in the number of shell rooms and the use of steam hoisting will produce the needed rapidity.

The essayist says of drills, "Uniformity of method is of less practical importance"; and of reports, "It should not be the object of such comparison to secure exact compliance with any arbitrary routine, but rather to make sure that a reasonable amount of practical instruction has been given." With this I beg to differ. I do not wish to be understood to say it is impossible to arrive at the same result by more than one method, but I submit, with all due deference to the powers that be, that one of our most crying evils is want of

uniformity; squadrons drill according to the will of the commander-in-chief, ships as the commanding officer wishes; and if division officers are to be encouraged in the same direction, individual caprice can go but little farther. The essayist seems to recognize this when he says later, "Officers must learn to decide questions arising during exercise according to their own judgment *within certain limits*"; which always has been conceded by the most ardent advocates of uniformity.

For the information of the essayist, I wish to state that the Copernican theory was taught first prior to 1464, by Cardinal Nicholas of Cusa; in 1504 by Copernicus, and in 1616 by Galileo. The famous recantation was made in 1633. As taught by Nicholas and Copernicus, this hypothetical theory continued to be taught after Galileo's death. Galileo's main proofs have been demonstrated false. Sir Isaac Newton was the first to demonstrate the truth of the theory. "It moves, for all that," has less foundation in history than Wellington's *spoken* remark, "Up, Guards, and at them!"

I close by asking if the executive officers of the Chicago and the Atlanta go aboard with this essay in their hand, how much will it aid them in organization, and how much will it aid them and others in drill?

Lieutenant CHARLES R. MILES.—*Mr. Chairman and Gentlemen:*—I find very little room for comment of a purely critical character upon that part of the essay relating to the proposed changes in drill, but upon the changes in organization proposed by the essayist he has not made his position so invulnerable. He has advocated one change under this head that I fear may prove a stumbling-block in the way of one of the most useful branches of our service, and I cannot remain silent and permit his views upon that point to pass unchallenged. I refer to his proposition to keep up "on a *reduced* basis" our present system of training apprentices.

Perhaps some apology ought to be made for taking the time of the meeting in discussing a part of the essay wherein the essayist seems to have strayed away from the subject somewhat; for I take the subject as given out by the Institute to refer to the changes in organization of the ship's company, and not to the changes necessary in the organization of the Navy. As the essayist, however, has made the subject elastic enough to include the reorganization of the present system of training apprentices, I feel that I am not altogether responsible for the digression.

I am sure that most of the officers of the service that have been associated with the intelligent American youths sent out from the training school will agree with me in according to this most useful branch a place of first importance in our naval establishment. That there are defects in the present system, I shall not attempt to deny; but upon the implication made that one of these defects consists in its having been established on too extensive a basis, I am prepared to take issue with the essayist. It may appear true, on first thought, that the numerical results of this attempt to Americanize the Navy are more or less of a failure; for probably not more than ten per cent. of the apprentices re-enlist immediately upon the expiration of their apprenticeship.

But I claim that this percentage does not represent the whole number of men of this class in the service at any given time, as many of those that retire to civil life undoubtedly meet with reverses, and in time drift back into the service. The essayist also seems not to have considered the valuable reserve force furnished in time of war for the Navy to draw from, by this very class of men that have retired to civil life—a class much superior to the raw levies that the Navy was obliged to accept to man its ships at the breaking out of the Civil War. I will venture to assert, therefore, that our Government would not lose by the bargain, should it increase this training service to twice its present basis; for, besides the increase in continuous-service men obtained, and the increase of the valuable reserve just mentioned, it would get from two to three years' service from every apprentice on board of the regular cruisers—a period during which, as has been satisfactorily proved, these apprentices would perform most acceptably the duties of ordinary-seamen, seamen, and, in exceptional cases, even the duties of petty officers. I believe the average apprentice of the 1st class to be superior in every way to the ordinary-seaman of former times, if we except their capacity for physical endurance, perhaps; and every apprentice of this class, when he becomes eighteen years of age, but not earlier, should be sent on board a regular cruising ship.

If the numerical results of the training service do not meet with the approval of the essayist, I wish to remind him that the fault lies not in the present system of training, but rather in the fact that sufficient inducements to remain in the service are not offered by the Government to these valuable trained men. In many cases, also, the officers with whom they are thrown after leaving the training ships take no especial interest in them, and as no attempt is made to wed them to the service, many naturally never learn to feel themselves an integral part of it, but, on the contrary, welcome the time when they can retire to civil life. I have in mind a case in point: An ambitious young apprentice, a leading boy on board one of the apprentice-ships, was sent to a regular cruiser, and there, for nearly a year, he was kept on duty as a messenger. Was it a wonder that his spirit was broken? or that he displayed what little spirit was left in him by endeavoring to get his discharge? I contend that a proper system of service pensions, better pay for petty officers and skilled men generally, and, finally, though not the least to be considered, juster treatment and a fairer estimate of the value of these trained youths by the officers with whom they serve, will bring about all that can be desired in regard to the numerical results of the present system.

In regard to the "mariners" or "naval volunteers" proposed by the essayist, I fail to see that the inducements offered them to remain in the service are any greater than those now offered to the apprentices; and, after much time has been wasted in training these raw recruits, I fail to see that we should possess any guarantee that they would not also retire to civil life at the end of their enlistment and thus produce the same inadequate numerical result complained of under the present system. The nautical habit and the love of a profession like ours are acquired early in life, and in a vast majority of cases at an earlier age than twenty-five. American boys, trained in the service and growing up with

it, will give us a patriotic and powerful fighting force of which in time we may well be proud. The man at twenty-five years of age that has not already chosen a profession will prove of little use to us, except in the performance of those simple menial duties that are usually performed on board ship by this same class of men at the present time.

The present system of training men, although yet in its incipiency, has proved itself one of our brightest jewels. Let us not be too critical about the details of the system, but let us unite, one and all, in assisting those that are engaged in the work by giving them our thorough co-operation and good-will.

Lieutenant C. D. GALLOWAY.—*Mr. Chairman and Gentlemen* :—I think the Institute and the service at large are to be congratulated on having received such a concise and lucid paper on this important subject. I believe from this article a compendium of rules could very readily be made which would improve the present methods, and which would wipe out much of the present routine nonsense.

As to what the essayist defines as seamanship, I take exceptions. Seamanship, in my opinion, is the correct care and handling of a vessel, no matter what her rig or motive-power may be, whether at anchor or under way among shoals or among other vessels; in gales of wind or calms; at single anchor, moored, or with springs on cables; either during offensive or defensive manœuvring, or while making passages. There can be but only one higher type of seamanship than that of conducting a ship from port to port at the great speeds now developed. The nerve required for such work, the judgment required in navigating her in bad weather and in good, is seamanship, and the kind that should be cultivated by all officers. The one higher type I have referred to consists in correctly doing what should be done when disaster does come, as shown by the way the vessel and crew are handled, and the most made of every device that can relieve the distress of the vessel, by the readiness of resource and exposition of nerve that have been previously cultivated.

As the opportunity now offers, I should like to say something upon the remarks made by the essayist on the subject of training seamen, and of the faults found by him in the present system. It is a lamentable fact that many of the best-trained apprentices do leave the service after reaching their majority, but some of them return after a short time; others would probably come back in time of war. In fact, I know that some of them return denying that they were ever apprentices, owing to the treatment received by apprentices on some ships. Many more of them would re-enlist within three months, if permission to go on shore and to draw and spend their own money were more freely allowed.

I think that all good-conduct men and apprentices should be allowed to go on liberty in our own ports, at least, either in citizens' clothes or in some plain dress similar to that allowed to yeomen, writers, and others. There can be no objection to it but prejudice, and perhaps the difficulty of identification in case of attempted desertion or straggling. The latter reason can have no weight, however, as in cases of this sort the uniform is readily exchanged

for old clothes, the "clean blue mustering clothes" being thus entirely lost. I am sure, from what I know from my own observation and from the opinions of fellow-officers, that such a simple change would keep many more men in the service: the reasons being that men in seamen's clothes have the doors of nearly all decent places shut to them, from barber-shops to churches. They are marked men, and the prey of sharps and runners. Their friends avoid them in public, and they are cut off from many of the amusements and pleasures open to a much lower class of society in civil life. Their pay is sufficient to enable them to have such clothes, and their more expensive blue clothes would thus be saved. I insist that this simple change in costume would encourage many men to remain. Much more might be urged to strengthen this argument, but it would be out of place here.

Officers should encourage the feeling that a seaman's position is an important one, and that each man is a very important part of the country's defense, an upholder of its honor, and his station much superior to many in civil life. If we can by fair treatment, and by giving good pay and good food, make our seamen proud of their position, of their ships, and of their flag, many more apprentices will remain in the service, and the more remaining, the higher type of crews we shall have, thus eliminating the weakest features of the present system as mentioned by the essayist. In the effort to retain good men in the service, attention should also be called to the classification and pay as shown in the Navy Register. To the eye of a layman the value of an article is to a great extent judged by its moneyed value, and to one glancing over that list it will be found that the actual fighting force of a ship's company is the least valuable. Compare any of the subdivisions, from petty officers, first-class, to seamen, third-class, and the result is the same. A chief gunner's mate gets less pay per month by ten dollars than a writer; a gunner's mate less than a cook, musician, or carpenter's mate; a captain of forecastle or top less than a painter, an oiler, or a printer; a seaman less than a lamplighter, a tailor, or a barber; and yet wonder is expressed that many apprentices fail to remain in such a service.

It seems to me the strongest means should be taken to encourage apprentices to remain, rather than to accept the essayist's idea of getting older men. The efforts of all officers, therefore, should be exerted to attain this end.

Lieutentant E. H. C. LEUTZE.—*Mr. Chairman and Gentlemen:*—As much that I intended saying has already been anticipated by those that have preceded me, I will only add that in making changes in the organization of our vessels I think it is necessary to begin at the top—that is, with the officers. I think with the essayist that it is high time that the lieutenants of our Navy should be relieved from the onerous and deteriorating watch duty which they have to perform in port. The junior officers who now are without definite status in regard to duty, could, if necessary, perform that service as well, if not better, not having lost all spirit and ardor by years of monotonous tramping up and down. If necessary, one of the lieutenants could be on duty for twenty-four hours as officer of the day. The lieutenants should be required, however, to

pay more attention to their divisions and have more frequent drills. One of them, I think, should be detailed as ordnance officer and have immediate charge of all articles pertaining to the battery, magazines, torpedoes, etc. It will probably be urged that the navigator will be able to perform that duty. In my experience, however, the navigator has plenty of work to keep him busy, especially, as being "the man who has nothing to do," he is ordered on every court-martial, board of survey, and any other duty outside of the routine that is to be performed.

While on this subject, I would like to put myself on record as being firmly convinced that it would be for the good of the service to have all commissioned officers in the wardroom. I would almost say all officers, but see many reasons why naval cadets should live by themselves. I think steerages are not only uncomfortable, unhealthy, and unfit for matured men to live in, but are positively indecent. Ensigns and those of assimilated rank are older men now than those of twenty years ago, many of them being married men, and these gentlemen are certainly entitled to some privacy and a spot where they can indulge in serious reading or study. We all know that they can have opportunity for neither in the steerage. They are sent on board ship and thrown in close contact with youngsters just turned loose from school, who may have been their pupils, or whom they may examine at their final graduating examination. I think the tone of both wardroom and steerage messes would be improved; the older men would become more dignified, and the younger, less frivolous and, perhaps, more respectful in their remarks about their seniors.

If it should be said that there is no room in the wardroom, then, as the steerages have to be retained for the cadets, I think it would be the lesser evil to knock down the bulkhead and take all officers into one mess. The breaking up of this one mess would also rid the ship of two non-combatants.

Lieutenant CHARLES BELKNAP.—*Mr. Chairman and Gentlemen*:—I think that in proposing this subject for the prize essay, the Board of Control of the Institute had in view the Chicago, Atlanta, and Boston, the only vessels we have at all modern; and since these vessels must rely entirely upon the gun for their offensive power, I regret to find that the essayist has not outlined a more definite plan for the changes in organization needed to exercise that power most effectively. The organization we now make use of has come down to us, with a few modifications, from the days when the weather gage was considered of the utmost importance; but under existing conditions the watch, quarter, and station bills should be made out with sole regard to the end in view—the development of the offensive power.

In regard to the changes in drill, I do not agree with the essayist in extending, if I understand him aright, the scope of individual idiosyncrasies. There cannot, perhaps, be too much uniformity in putting the principles of so exact a science as gunnery into practice. The disadvantages of latitude seem to be tacitly admitted by the essayist, as he discourages changes among divisional officers. Were the practices carried out uniformly, a change of divisional officer could produce nothing more than physical effect.

To gain uniformity in exercises, the Ordnance Manual should, in the first place, be rewritten, separating it perhaps into two volumes. In addition, each ship after being put into commission should be placed under the instruction of the Ordnance Bureau until a thorough course of exercises should have been gone through with, involving all the varied circumstances in the uses of the offensive weapons on board. With headquarters in Lynnhaven Bay, for example, the ship could put out to sea, perform the various exercises under direction of an officer specially detailed for the purpose, returning daily to the anchorage, where targets could be carefully examined to show results attained, until all understood the manner in which the bureau wished the exercises carried on.

The results attained at different times during the cruise and before going out of commission would, by comparison, show the value of the course of instruction and exercise pursued.

I will not trespass any further upon your indulgence by indicating the series of exercises to be pursued; they naturally embrace all where hitting an object with a projectile is concerned. But such I believe to be the changes in drill and exercises needed to fight the new cruisers most effectively.

THE CHAIRMAN.—Lieutenant Calkins is to be congratulated on being the first person to be twice successful in writing the prize essay. I am sorry, however, that he is not present to-night to answer for himself; no doubt, if he were, he would clear up much that seems obscure to some of those who have taken part in this interesting discussion. The paper has been so ably debated that little is left for me to say.

The Board of Control, of which I was a member, in selecting this subject, hoped to set officers thinking about the new Navy, so fondly hoped for. The seven essays submitted in competition show that its hopes have been realized.

It is evident that reorganizations of the *personnel* and drills are necessary to manage and fight properly the new ships. But I think the essayist loses sight of the modern improvements when he proposes to fill the ships with as large crews as they can berth. The effect would be, so to speak, to make too much food for the enemy's powder. The tendency of the age is to have machinery take the place of muscle; of machine guns to replace regiments, and of engines to "sheet home" and "hoist away," instead of hundreds of men to the music of the bugle. If there is a desire on both sides to engage, head-winds or calms will not prevent. The action will be of short duration; therefore, the ordinary crew will not be overworked. For the purpose of training men, the crews might be as large as the essayist suggests.

It is to be regretted that the author, while treating so liberally in generalities, has not gone more into useful detail, so that one might know how he would organize, equip, arm, and station a ship's company, and afterwards exercise it, and fight the battle.

On the motion of Commander Huntington, U. S. N., a vote of thanks was tendered to the Prize Essayist.

WASHINGTON BRANCH,

MAY 19, 1886.

Rear-Admiral EDWARD SIMPSON, U. S. N., President of the Institute, in the Chair.

Commander A. D. BROWN.—*Mr. Chairman and Gentlemen:*—I have jotted down a few points in the essay that attracted my attention in reading it, concerning which I propose to offer a few words, without attempting to discuss the paper as a whole. I think it may be said, however, that our author has given us a very good paper; certainly he has laid out a good deal of work for those who are to have the control of our new ships.

Reference is made to the training system and its inadequate supply of men, with the intimation that it is regarded as our only dependence for supply. I do not think this can be the case, for in the complement of the Atlanta there are 28 landsmen—a pretty fair proportion as things go.

I think that the essayist is correct when he says that there should be no marine officers with the guard. I see no reason why the relation to the ship of the officer commanding the marine division should be different from that of any other divisional officer; and the laws do not appear to contemplate the necessity that is supposed to exist for this being the case. If we can make no use of the nautical training of the junior marine officers, we are better off without them on board ship. I say this without disparagement to them or to the gallant corps to which they belong.

Again, our author says that "every man should belong to an efficient military organization"; in this I heartily concur, especially if he includes in the term *man* the officers as well. In a paper which I had the honor to read before the Institute some years ago, I said that "every officer, except the medical officers and the chaplain, should be a combatant sea officer, a graduate of the Naval Academy," and from the opinion then expressed I see no reason to dissent; in fact, the necessity therefor seems to be every day more apparent.

A caution regarding the position of the three senior officers in action is well timed; it might be a matter of some interest to ascertain the probable chances of the survival throughout an action of the gentlemen who are to occupy those honorable situations; it does not seem likely that all of them would be able to pass through the fire of machine guns unharmed, and I suppose that it would be a mere question of duration as to the officer upon whom the command would fall after an action was closed.

I am entirely at one with Lieutenant Calkins in his denunciation of competitive drills in which time is to be made; for I consider that there are no words too strong to apply to them; they foster careless and slovenly work, and are of no earthly good whatever, that I can see. "Gilguys and gadgets" are in the highest degree unseamanlike, and though I must plead guilty to having used them at an earlier stage, I must, in justice to myself, say that it has been only because the other fellow was doing the same thing without rebuke from our common superior. In general, the remark of the paper upon the subject of

the character of the drills to be pursued is excellent, and many of the suggestions might be carried out to advantage in our older ships.

It is evident that there is a spirit of improvement abroad in the Department, for we have recently seen the North Atlantic Squadron displaying its naval power, or rather its want of that power, in a series of drills which, while they seem to have had a good deal of the time system in them, yet must have been productive of much knowledge on the part of all concerned, especially that portion of the officers who rarely have an opportunity for handling their ships under way. More of this should be done as suggested.

It occurs to me that we have presented to us an excellent plan for the service of the ammunition; certainly none could be much worse than the present one under which the powder division is exercised. I remember to have heard our honored president say that "the powder division was the most important one in the ship," and, if I am not mistaken, in one vessel commanded by him it was placed in charge of the senior instead of the junior watch officer. At all events, I should like to have the proposed experiment tried in the Atlanta, to see whether it is the improvement I think it.

It seems to me a matter for regret that we are obliged to have so large a proportion of our force afloat belonging to the non-effectives; in our ships the ratio is, I believe, higher than in any other service; and this state of affairs is continued in the new ships. In the Omaha and Atlanta the proportion of the different branches is as follows: servants, 10 per cent.; special, 14; engineer's force, 20; battery and spar deck, 56. While it does not seem reasonable that there should be 24 per cent. of almost entirely non-effectives, yet it will require the exercise of great judgment on the part of the authorities to reduce this ratio; and perhaps I may say a great change in the ideas of officers, both in command and in inferior positions, to cause a proper disposition of the force placed at their disposal. I am sure that the number of servants could be materially decreased without any sacrifice of the comfort of the officers, while adding materially to the efficiency of the ship; and this is, I think, the first place where the pruning-knife should be used.

The essayist is not far out in his estimate of the number of men that the Atlanta will have. According to the present complement she will have 193, exclusive of marines, the engineer's force being 41. If we go back to the old fashion of having but two watches in the fire room at quarters, there will be left 163 men from which to draw the four divisions mentioned; from these must be deducted five for the surgeon, leaving 158; of these there are 19 servants, 11 engineer's force, 8 artificers, 14 first-class petty officers, so that the number of reliable men from which to draw is greatly decreased; still we would be able to have the divisions almost as large as contemplated. The second relief would not be a full one; with that exception the plan could be carried out, and I think that it is certainly worth trying.

I cannot close these brief remarks without saying that I think we make altogether too much of watch standing, and that to exact port watches is calling upon men to do too much. Where all the line officers are standing watch there would be no need for doing duty in this way; it fosters the idea so very preva-

lent, that when one is over his day's duty he is off until the next tour begins—a most pernicious doctrine, which leads one to forget that the first duty of every officer is to the ship upon which he is serving, and that practically speaking that duty is (like that of the executive officer) never done. Our ensigns are of the age at which the lieutanants of the war period, and immediately after, did their duty; and many of them are as old as are some of the captains now on the list when they held their earliest commands during the war. It will be observed that our author does not propose to lessen, but rather to increase the amount of work to be done, and therefore the change in the method of standing watch is an essential portion of his scheme. In three watches (where there is so great a misfortune) an officer of the day would be all-sufficient. In conclusion, I desire to tender my congratulations to Lieutenant Calkins for the manner in which he has enunciated his views, and I hope, with him, that they may prove of practical benefit to the service.

Lieutenant-Commander C. H. STOCKTON.—*Mr. Chairman and Gentlemen:*—This essay is found to be most interesting, being critical and suggestive, and, to a less extent, constructive. Taking the treatment of the subject, as given by the Naval Institute, as the matter alone to be discussed—*i. e.*, the changes in *organization* and *drill* that are necessary to sail and fight most effectively our war ships of the latest type—I find the changes suggested in *organization* are few in number and to my mind not too radical.

They can be stated briefly as follows:

First.—The equalization in numerical strength of the divisions; the union of the effective men of two divisions as a company of seventy-two men; with provision for relief crews and ammunition passers as an integral part of the division.

Second.—The consequent abolition of the powder division.

Third.—The change of the navigator's division into a division of equal numerical strength as the others; but with duties in addition to their former ones of riflemen and of working the rapid-firing guns of the tops, etc. This division to be in charge no longer of the navigator.

No decrease in numbers of the men on board is favored, except in the number of servants, but a complement which will fill the ship without crowding is advocated. An additional system of classification is also urged, making proficiency in drill the basis.

I agree very decidedly with the essayist in the idea mentioned of equalizing divisions. This has been done, and is done to a great extent at present, and the advantages of having such units in organization can be readily appreciated in the formation of companies of infantry, sections of artillery, boats' crews, messes, etc. When practicable—and from our knowledge of the possibilities in these ships it seems feasible—I think all will assent to its advisability.

In regard to the suggestion of the formation of a company of seventy-two men from two of the divisions, I cannot but regard it of doubtful utility; besides the breaking up of the divisional unit and placing the men under an officer of another division, the advantages of a smaller company of from thirty-

four to thirty-six strike me as greater. Besides being formed of the effective men of one division, under their own officers, it is a smaller unit, less unwieldy, occupying less boat space, and, hence, less likely to be scattered, and in addition also feeling more strongly and directly the personal influence of the officers and of divisional companionship.

The provision for relief crews and ammunition passers, and the abolition of the powder division, in my judgment is a good one, and tending to increased efficiency in the working of the battery and service of ammunition. It provides in broadside guns for the manning of each gun in an efficient way, besides furnishing trained men to replace deficiencies caused in action. As for the ammunition supply, as proposed, it is more under the control of the officer most concerned, renders the division independent and self-supporting, and the interchangeability of the men will make the division, I think, in every way stronger.

The change in the navigation division I think most excellent; and in addition would suggest the placing of the marine guard and its officer as an integral part of this division, to do the duty of sharpshooters and riflemen, and man a portion of the guns in the tops. From recent experience I found that the marines were sufficiently active and serviceable aloft for that duty; and as we have shaped the sailor into an infantry man without making him a soldier, I think we can readily station the marine aloft, and give him sufficient flexibility without attempting to make him a sailor. The marine guard as ordinarily drawn up at general quarters only serves as a most tempting target for machine guns.

The argument in favor of a complement that will fill the ship is a strong one, and in marked contrast to the reduction of complement suggested by Commander Glass in his recent paper published by the Institute. No matter how improved and how great in number the mechanical appliances on board may be, there should be an effective force for landing purposes and detached operations, the absence of which should not entirely disable the ship. It is a simple impossibility for military detachments or wandering transports to do the work liable to be demanded for the emergencies that may arise, and which can be so well and readily met by a large or small force from a cruising war ship.

In regard to the classification of the men according to their training and drill, it seems a move in the right direction, and opens up possibilities, in a far-reaching way, of a substitution for the present system of classification according to seamanship alone, based as it often is upon service in the merchant marine of a character entirely foreign to naval duties.

The changes proposed under the second heading—*in drill*—can be summarized as follows:

First.—Drilling by watches in port.

Second.—Abolition of competition among ships for the first six months of the cruise.

Third.—Greater attention to aiming drill and marksmanship in general.

Fourth.—The abolition of the cutlass and pistol and their drill.

And as minor changes: The working of the guns at daily inspection, and the establishment of four rigs.

More extensive drilling by watches in port is desirable, and is, I think, more practicable in our newer ships. It has its limits, and the writer has, I think, reached one extreme in his proposed drill routine for the morning watch in port. For reasons suggested in the essay, it would be most beneficial, while not absolutely abolishing competition, to limit it to two or three drills in that time, so as to enliven the ship as a whole at rare intervals.

The importance of much greater attention to aiming drill, though strongly stated, cannot be too forcibly urged, and its value cannot be overestimated.

In regard to the cutlass and pistol, in my opinion the cutlass is a thing of the past as a gymnastic exercise. Its drill is inferior to the pure gymnastics as practised in the French Navy. The pistols furnished to ships, with which I have had experience, I think can be dispensed with as of little value, though I admit the value of a good weapon, well handled.

The daily working of guns at inspection I consider a decidedly good plan, mechanical carriages and appliances making it almost necessary. A visit to the Esmeralda a year ago, at Panama, showed the carriages there in bad condition, with the more delicate parts badly rusted, and an evident neglect of constant manipulation of the mechanical appliances.

The rigs, suggested and classified, though not novel, can be usefully combined, and the provision for their use in the system of signals can be readily made.

An omission of sufficient stress on ship-torpedo drill is noticed. No matter how indifferent is the plant with which we are supplied, we should have our men more frequently drilled. If the system is radically bad, the application of the maxim in administration, that "the best method of securing the repeal of a bad law is its enforcement," might be of use. These torpedoes are still manufactured and supplied, and that fact encourages the vague reliance placed upon them by the outside world.

In regard to what is said about the apprentice system, I have been so unfortunate as to have no exact knowledge of how matters stand, and what the statistics are upon the subject. I should not like to form or advance any opinion from the very limited field in active service from which I could alone judge. In addition I have discovered only general statements of an unofficial nature that do not cover the whole ground. How large the number that graduate each year into the service is, and what the cost *per capita* of each so entered, I do not know. I hope we shall be able to get the statistics of the system, and not have to depend upon generalities alone, more or less glittering though they be.

Lieutenant W. H. BEEHLER.—*Mr. Chairman and Gentlemen:*—The admirable essay under discussion seems to cover the ground so generally that it is difficult to find many features which will not meet with general approval. There are, however, a few points which might have been more thoroughly elucidated in order to offer practical suggestions to remedy the evils of our present organization and drill.

Certain changes in regard to the classification of our enlisted men are suggested, but they do not go to the root of the subject. The organization of the *personnel* should be completely changed in order to meet the growing requirements of the service. The essayist claims that the apprentice system has failed, and in lieu thereof suggests that "young men of good physique and intelligence" be enlisted and given "a rapid course in military training while they are acquiring the rudiments of seamanship by serving in cruising vessels."

This is, however, the aim of our present system. I believe the true remedy lies in lengthening the period of enlistments and to have each re-enlistment a graded sequence of the preceding. The present system of continuous-service men is an effort in the right direction, but the chief consideration in view is to provide pay and certain emoluments as a bounty for re-enlistment, while but little account is taken of the professional attainments of previous enlistments. The latest types of war ships require a specially trained *personnel*. The man-of-war's man of the present is not merely a sailor, but must be a skilled artillerist, a well-drilled infantry soldier, a machinist, a torpedoist, as well as a sailor, qualified for all kinds of strictly nautical work, such as boatman, topman, helmsman, etc.

The period of five years is necessary for efficient service in the Army and Marine Corps, where only one or two of the foregoing qualifications are required, and surely this term is absolutely necessary for the Navy. Not that a cruise should be for five years, but that the enlistment be for that term. The first and last years of each enlistment should be spent on shore in barracks at the navy yards, where a much more efficient course in military training can be given, rather than while serving in cruising vessels. This would leave two-fifths of the entire enlisted *personnel* on shore and three-fifths in the cruising vessels. This, however, is not such a radical measure as would seem, as there are about five thousand men (generally less) serving in the ships on the *five cruising stations*, exclusive of the boys, while the entire force is seven thousand five hundred men. The essayist presents no scheme for a prompt mobilization of a reserve, because none is contemplated, whereas this plan enables the mobilization of a reserve equal to two-fifths of the entire Navy. In the present time war follows upon the receipt of telegraphic information, and the necessity for an immediately available naval force is the most striking feature of the times.

The organization should be thorough in all details. Each man should be enlisted for a certain ship; the ship should make a three years' cruise, and be held in reserve during the first and last years of every period of five years. The crew could then live in barracks while their ship is in reserve, and except when undergoing extensive repairs will be available for immediate service, with reduced complements, perhaps, owing to temporary absence of the deserving on leave for portions of this period. This reserve would supply a needed organized naval brigade at each naval station for any emergencies.

The classification suggested by the prize essayist is not sufficiently thorough in providing for a regular graded promotion of the men to petty officers and warrant officers. The petty officers should all be regularly graded, and em-

braced in different special branches, so that proficiency in one grade should lead directly up to the next higher; then on to and including that of warrant officer. For example, captains of tops to become boatswain's mate; then chief boatswain's mate; then boatswains; ranking respectively as corporals, second sergeants, first sergeants, and warrant officers. The torpedo *personnel* should, in like manner, have graded petty officers such as might be: Torpedo mechanic, torpedo mate, chief torpedo mate, torpedoist, with relative rank of non-commissioned and warrant officers respectively. All the unorganized *personnel* of petty officers can be so grouped with relative rank that the status of every man may be thoroughly defined as in one of the following branches—viz.: Gunners, boatswains, masters, artificers, torpedoists, machinists; and the remainder, such as baymen, apothecaries, writers, cooks, stewards, and storekeepers, be assigned the relative ranks of non-commissioned officers, not to reach the grade of warrant officer. This will introduce two additional branches of warrant officers—viz.: torpedoists and machinists; the titles of carpenters and sailmakers being changed to those of artificers and masters. The masters-at-arms and ship's corporals should be selected from the *personnel* in the boatswains', gunners', and masters' branches of warrant officers, and permanent petty officers. The difficulty of obtaining such men will be obviated by the adoption of some plan like this. The duties of the master-at-arms and ship's corporals are such that they must be good seamen in order to have the personal respect of their shipmates. The occasional detail of those so qualified, as will be ascertained from properly kept records, may be considered as a sort of detached duty for the cruise of the ship to which they may be assigned. Some such system must be introduced in our organization if we ever hope to Americanize our Navy. Americans are ambitious to occupy positions of trust and responsibility, and this scheme affords them some chance of gratifying their ambition as warrant officers. It does not pay Americans to ship.

The petty officers should be permanently attached to the Navy, and all those who reach the grades of first and second sergeants should have their names in the Navy Register. A certain amount of pride in the service, together with a permanent interest in the welfare of the Navy, will ensue, and contribute very much to Americanize the Navy. There is no hope for much improvement in the individual status of the enlisted men in our present organization. The enlisted man is no better off after a cruise than before, except, perhaps, by a little experience and a small sum of money, which is immediately squandered. Our present organization is the chief obstacle in the efforts to obtain young Americans for the service.

The five-year term of enlistment will also contribute, as explained, to improve the *personnel*. When a ship is commissioned her crew will have had a preliminary training of one year. No vacancies will have to be filled by enlistment of foreigners when on the cruise, and all the evils attending the wholesale discharge of men immediately after their return from a three-years' cruise, and the expense of extra pay for overtime men, will be obviated. The continuous-service certificates would have to be modified to suit this change in the period of enlistments.

The equalization of divisions in force and efficiency advocated in the essay sounds well, but it is practically not as feasible in the latest type of war ships as in the obsolete types in sail at present. The essayist seems to overlook the chief features of the modern war ship's armament: the primary battery of high-power breech-loading rifle, the secondary battery of rapid-firing, multifire and machine guns, and the torpedo armaments. He does not provide for any torpedo division, as if it had been definitely decided that the pot on the end of a pole is to continue to be our only torpedo armament. It is true that we have no other torpedoes yet, but then we have no modern ships, either. The organization of a torpedo division, comprising the trained torpedo *personnel* to manipulate the torpedo-launching tubes, cannot be placed in command of a divisional officer on the battery deck, otherwise fully occupied by his duties in charge of the battery.

The proposed abolition of the powder division I consider a very wise measure; but the reasons and advantages of the change are not fully specified, though a little reflection will satisfy almost everybody of the necessity of having the ammunition supply of the guns under the control of the gun divisional officers.

Some other features of our organization are not referred to in the essay, such as fire quarters. Only a few changes in the details will be necessary for the latest types of war ships. The present practice is therefore sufficient. There is, however, nothing said about the necessity, arising out of the great speed of a modern war ship, for having an organized detail for "Collision Quarters." The most prolific cause of disaster is undoubtedly what may be classified under collisions, including all accidents, such as grounding, colliding with other vessels, and shipwreck. The liability to collisions is much greater than hitherto, because of the great speed by which only a few moments intervene during which ships meeting are in sight of each other. Collision quarters should be prescribed in our organization similar to the organization of fire quarters. This should be of such a character that every possible emergency may be thoroughly provided for.

The essay contains many valuable suggestions concerning the changes in the drills, and some features will not be accepted immediately. The necessity for more thorough and more elaborate aiming drills is very ably discussed, but I think it should have gone further, to include annual prize firing throughout the Navy. Substantial money prizes should be awarded for superiority in the contest, provided a certain standard be attained. This should be minutely prescribed by the Navy Department, and be uniform throughout the service. Some special, distinctive mark, as flying a peculiar dogvane at the main, may be authorized for the ship which wins the annual prize. The methods in vogue in the English Navy may be adopted with a few modifications.

I regret that there is so little said about torpedo warfare. This is now recognized as a most important factor, and there should be constant drill with fish torpedoes and submarine mines. Every ship should carry a complete system of submarine mines, with cables, etc., so that it would be possible for her to protect a harbor of refuge. There should be drills in laying out the system of mines, and drills for attacking them. Without this practice the mere announce-

ment that a place is defended by torpedoes will, perhaps, deter an attack which political reasons may demand as absolutely necessary. There is no definite plan proposed for defending ships against torpedo attack. The torpedo net is now recognized as the most effective means invented, and our ships should be supplied with it and their crews exercised in handling the net. I agree with most of the ideas suggested in this essay, but there should be a more thorough organization of the enlisted *personnel*, and provision for the drills I have enumerated, in addition to those advocated by the prize essayist.

Ensign W. L. RODGERS.—*Mr. Chairman and Gentlemen:*—As I have written an essay on this subject which is to be published, I feel at liberty to criticise the admirable one now under discussion without making any suggestions. The author very early says that "the services of the Marine Corps as a police force are invaluable and justify its continuance in spite of the want of adaptability of its system of training to nautical conditions." I prefer to invert and reverse the sentence, and would say that the want of adaptability of the Marine Corps system of training to nautical conditions justifies its discontinuance in spite of its valuable services as a police force. I have not the slightest wish to belittle the past great services of the Marine Corps, but the subject under discussion is the attainment of the maximum efficiency of our modern ships, and the question is whether men reach their greatest "all-around" usefulness and fighting efficiency for naval warfare when trained and organized as marines or as blue-jackets. For myself, I think that at the present time in our service the marines are better drilled, more reliable, and more efficient in their line than are our blue-jackets; but we will all acknowledge that a thoroughly good seaman well instructed in all his duties is a more useful man for general naval service than is an equally good marine. The blue-jackets at the recent encampments have proved reliable as police, and it is probably only necessary to trust them in order to find them trustworthy. As regards the special duties of landing parties, the marines are a small minority of the total force, and certainly we must admit that the French, who have no marines on shipboard, did not seem to feel their absence at the brilliant capture of Sfax. I would, therefore, conclude that as soon as we have a good body of blue-jackets the marines will be no longer called for.

The next point to consider is the organization as proposed for the Atlanta. In the first place the author proposes to do away with the powder division, alleging that the commanding officer cannot control its detached squads in time of action, and charging the well-known inefficiency of the powder division to this cause. It seems to me that the powder division is comparatively inefficient only because the executive is content to have it so. The author says that the officer of the powder division must be ubiquitous to ensure efficiency; but he seems to confuse the nature of his duties with those of the lieutenants of the gun divisions. The latter have to make their initiative felt at every moment of the battle; the former has merely to establish at his leisure a system which shall work mechanically in action, and this does not call for ubiquity. The confusion that would arise from each division procuring its

own ammunition must be very great, and I cannot see the weight of the arguments urged in its favor. The next point is that divisions should be of equal force and efficiency. It seems rather that equal force would cause unequal efficiency, for if we compare the first and second divisions of the Atlanta as proposed by the author, we find (neglecting the rapid-firing guns) that a round weighing 525 pounds is provided by nine men of the first division, while thirteen men of the second division provide a round weighing 300 pounds. If we consider the rapid-firing guns, the disparity in the service of the heavy guns is still further increased. The author then sketches out an organization for the Atlanta for a complement of two hundred and thirty men. It will be admitted that this is a sufficient complement, though not large. He sets aside fifty men for first-class petty officers, a small marine guard and a strong engineer's force. In the British Navy the horse-power per man of the engineer's force varies from sixty to one hundred and twenty, but for ships of the type of the Atlanta it is fairly constant and may be regarded as about eighty-five. This allows forty-one men for the Atlanta's engineer force, and adding four men that we may have a strong force, we have five men left for the first-class petty officers and the small marine guard. The remaining one hundred and eighty men are divided into four gun divisions, each forty-five strong, and the author states that the natural arrangement would be to put three of them to man the primary battery, leaving the fourth for the rapid-firing guns on the upper deck and in the tops, to assist in navigation and to act as small-arm men. When the Chilian ironclads captured the Huascar they had twelve men in each top. If we adopt this arrangement for the Atlanta and put two men at each Hotchkiss gun—one to load and one to fire—we will have five men left to supply ammunition to the Hotchkiss battery, to assist in navigation and act as small-arm men on deck.

But instead of the arrangement which he says is natural, the author adopts something else. He puts an eight-inch gun mounted *en barbette* on the main deck, a six-inch gun under the superstructure and two Hotchkiss on the superstructure, all in one division. The development of the use of voice-tubes and telegraphs advocated by the author must be carried very far to ensure to the lieutenant his control of such a division. What becomes of the fourth division in this organization is not apparent: either it mans the other two broadside guns, when there is no one left for the tops and deck work, or, as this seems contradicted by the context, it goes on deck as a division of riflemen, when it violates the principle of reliefs for each crew, and seems superfluous, as the reliefs of two divisions are already available as riflemen. But by a hasty examination of the probable distribution of the Atlanta's crew of two hundred and thirty men, I think that we may arrive at an important conclusion regarding the engineer's force. As I have already said, there will be about forty-five men in the engineer's force. The structural arrangement of the ship is such that at least forty-five will be required for providing ammunition: in a word, for the powder division. There will probably be twenty-five marines. This makes one hundred and fifteen men. If we place five men in each top and allow for five carpenters in the wing passages, and five first-class petty officers,

ten men for general service about the decks, signal men, baymen, etc., and three men for each of the eight Hotchkiss guns, or say twenty-five men, we shall have a total of one hundred and seventy men, leaving sixty men for manning the eight guns of the primary battery. It will be generally admitted that a ship should be able to detach half her force and still remain fairly efficient. Let us see how we can make up a landing force of even one hundred men. I will assume that thirty men can handle the primary battery upon emergency. We thus have thirty men to land. The powder division is already none too large, but let us take ten from it. The marines (twenty-five) will all go. One of the Hotchkiss guns on a field carriage with its crew may be able to make up twenty men from those in the tops and about the decks on general duty. We cannot take any one from the secondary battery, for they have none to spare. We thus have a total of eighty-five men. As the engineer's force is the one whose services are least likely to be urgently needed when a detached expedition is called for, the conclusion seems inevitable that it must be thoroughly trained as a combatant force and send a large contingent to the naval brigade.

Watch drills, I believe, have long been discussed in the service, and it seems strange that they have never been adopted, although they have all the advantages enumerated by the author.

As gymnastics seems to be the only object of the proposed exercise of squaring yards, it is worthy of consideration whether it would not be better to form a column of fours and double time around the deck for fifteen minutes every morning.

The use of single-sticks as an exercise is condemned by the author because it develops no interest or instinct among seamen. There are two excellent reasons for this: no masks are furnished and officers take no interest in the exercise. If these matters were remedied, it seems as if great benefit would follow from single-stick drill.

In regard to what the author says of the present method of standing watch, it is probable that the great majority of officers will agree. Officers should stand days' duty without regular watches when in port, for it is impossible for them to be thoroughly efficient and take a proper interest in drills and studies when they are compelled to spend on deck a large part of every night absolutely without object, except concession to custom. That the present method is really unnecessary is shown by the custom of other services, and by the fact that commanding officers, who alone are opposed to change in this respect, make it a general rule not to come on deck during the night, although they must be aware that officers are not strict about walking the deck, and thereby, as it is claimed, endanger the safety of the ships.

Mr. Beehler wishes to keep petty officers in the service, and hopes to do so by entering their names in the Navy Register. There must be given some more substantial reason than that. The English system has given excellent results, retaining a good class of petty officers, and as this gives a tried system ready for use, we might adopt that without seeking further.

In regard to what the author says regarding the closer association of officers

with their divisions I think almost all will agree; and in this connection I would like to suggest the advisability of making the quarter and other fighting bills more flexible by committing more authority to divisional officers. At the present time it is usual to have a most rigid connection between the different bills, and a man's gun and number at the gun, his boat and company, are absolutely determined by his watch number, producing results frequently unfavorable to fighting efficiency.

It seems as if fighting efficiency would be increased and executive officers would be relieved of much work by making the quarter bill the basis of organization, so that officers would always command the same men in any of the fighting organizations; and then the complete control of the internal organization of the division should be turned over to its commander, who should station his men at the guns and make the detail and organization of his company subject only to the Ordnance Instructions and such general rules as the executive officer lays down.

Commander WINFIELD S. SCHLEY.—*Mr. Chairman and Gentlemen:*—I would like to make a few remarks upon the subjects treated in this essay, but I will premise them by the statement that the essay presents itself to my mind as an extremely aggressive argument, though I endorse it as a whole, because I feel that it is absolutely necessary that assaults of this nature should be made upon that conservatism of our service that tends rather to retard what under modern development may not inappropriately be termed the new or higher seamanship.

There are some of the author's statements with which I cannot agree, particularly those in which he attacks the present training service and states that it has failed to produce continuous-service men, and therefore the system is a failure. If the essayist had known more of this matter under discussion, I question if he would have committed himself to such a remarkable utterance.

At the outset I ought to say that the training system of our Navy differs radically from that of the British. In England a large proportion of the population are seamen, and the main object of their training system is to secure a class of trained petty officers, while with us the decadence of our merchant marine has made it necessary to train our boys first to be seamen and subsequently to be petty officers. It must be seen, then, that the training process is necessarily longer, and much more time will be necessary before the absolute result can have been determined. When I state that present results to the service at large justify the statement that nearly 15 per cent. of the service comes from the training system, it hardly bears out the statement of the essayist that the system has failed; and when we remember that a fair proportion of the crews are composed of apprentices under training, the per cent. is apparently increased.

But a much better and broader view of this system would not ignore the great benefit and advantage which must directly accrue to the community at large. Though many of these boys may leave us at the expiration of their apprenticeship to improve themselves financially, there can be no doubt that

in the event of war many of them would find their way back again. Are not the masses from which these boys come impressed by the example of those who return in better condition than when they left their homes? Can a system be said to have failed which returns boys to a community disciplined and self-supporting? Does not the country directly benefit by having large numbers of boys already trained to the requirements of her defense whenever the time shall come for their need?

I think we can fairly trust that these trained boys will have patriotism enough to return to the Navy whenever the emergency may require them. If they do not, they will be very unlike most Americans.

Touching the matter of organization, I think that any one of our profession who has reflectively witnessed the wonderful advance of the last few years in constructing, in defending, and in protecting the modern war ship, must have observed that old types were giving way to new machines, and that new methods and newer instruments of all kinds were superseding the older; all of these changes mean that there are to be changes of organization, of training, and of preparation of the *personnel*, to adapt them to use on board the new type of war ships. All these things are just as certain as that the electric light has succeeded the tallow candle, and that a new education was necessary for the management of the former.

The fact that machine guns are so largely a part of modern armament indicates very clearly that the loss of life in future naval combats is to be infinitely greater than ever before, and this alone would appear to emphasize the necessity of obliterating all distinctions of corps as now organized. I think that every officer, except the surgeon, should receive such military education as will fit him to succeed to command.

A general order has just been issued by the Honorable Secretary of the Navy looking to the reduction in the non-combatant element on board our ships, which under old traditions had grown to 46 per cent. of the force on board such a ship as the Chicago. By this order all men belonging to the "artificer" and "special class" are required to be drilled in the use of great-guns, machine guns, small-arms, and all other implements of attack or defense. This order reverses old organization, and is but the beginning of a new system under which the Navy will be improved when it shall have had full effect.

What would be the effect of an attempt to justify the defeat of a national vessel by the statement that 46 per cent. of her men were untrained to her defense? Who could withstand the vengeance of the people if a ship still capable of resistance had been forced to surrender with nearly half of her *personnel* uninjured, but untrained to warlike uses, or unskilled in the higher seamanship of manœuvring or defending her?

It is these facts which ought to suggest change of adherence to or adoration for our effete organizations, and for one I accept the essayist's suggestions as a move in the right direction.

There is something to be said for the old drills, when it is remembered that their purpose was twofold: First, as a means to discipline and order in holding the ship's company under quiet control for two or three hours each

day; and second, as a means to secure uniformity and efficiency in working together simultaneously in performing evolutions with spars and sails that emergencies at sea often require done quickly and together. If "gilguys" are used to secure quickness rather than security, the fault lies more with the commanding officer who permits such makeshifts than with the system of drilling. My own experience in the various ships in which I have served as executive or commanding officer was to forbid such things. I always felt that the purpose of the ship's exercise was to secure the highest proficiency, and without the use of any "gilguys" it was accomplished to a remarkable degree. I always felt that nothing was well done unless completely and thoroughly done.

The essay is exceedingly discursive, so that in one reading it is impossible to take it all in; but my own thoughts for a number of years have tended precisely in the same general direction, until I was beginning to feel that I might be to some extent a "crank" in this matter. I believe in the march of progress now going on; that masts, except military kinds, and sails must disappear; they must go; and the plea of many that we are to be professionally injured when they do disappear, I do not believe to be tenable. In a great degree they have disappeared from the merchant service, and I am sure we find that service more efficient to-day and the carrying trade quite as well taken care of as in former days. I had the pleasure, last summer, of making a sea-trip in a fine steamer the mate of which had never served in a square rigger, and a finer sailor, with more nerve or fuller of expedients, I never met.

Let me compare the qualities needed by officers who have to drive their own vessels in a fog on to the coast eighteen knots an hour to make time with those under similar circumstances approaching in a sailing vessel at five or six. The judgment and nerve of the former are not comparable to those required in the latter. The former demands training to the men and higher seamanship, and without this skill the newer war vessels would be of no use.

The essayist refers to continuous-service men of the Navy, and allusion has been made to-night to the advantages of five years over three as the period of enlistment. I would state that there are to-day 7200 men afloat, and of this number there are about 3000 continuous-service men, and this appears rather a good showing. The period of five-year enlistments is a matter about which there has been considerable discussion. No doubt the custom of enlisting for three years grew from the fact that all the laws referring to re-enlistments have a three-year condition as necessary to secure the gratuities of pay. It is a question whether men would not be cut off from the three months' pay now accruing to those who re-enlist within three months after discharge, if the period were increased to five years with the law stating three as the necessary condition. It is at least certain that the law must be changed, and this you must all know is not an easy affair. I have made a number of suggestions to the committees all looking to the betterment of the condition of our men, but up to this time we have not succeeded in securing what appears to me so necessary. If any one present feels that the task is easy, I cordially invite his assistance. At all events, I understand now for the first time in my life how to reply to that constant inquiry in the service, "Why don't they do so-and-so?"

The essay as a whole is an exceedingly instructive paper. Though faulty in some particulars and epigrammatic in others, yet it indicates to my mind that there are others who think and believe as I do about the changes that are surely in sight for the new Navy and its organization. I can even see, in the new necessities that are to come with the new ships, that there will be changes in the names of such personages as captain of top, captain of afterguard, quarter gunners, and the like. These distinctions of title will be swept away, to give place to others that will better express the duties that men are to perform. This may seem extreme, but if we look backward for twenty years to the monitor days, there must come the conclusion that if we had continued to develop that class of ships, we would have long since substituted names and distinctions for the men who served them that would have expressed their duties, rather than have continued distinctions of title which belong rather to the traditions of the days of Trafalgar and the Nile.

Assistant Naval Constructor BOWLES.—*Mr. Chairman and Gentlemen:*—A greater familiarity with the arrangements of the Atlanta would have considerably changed the criticisms of some on the prize essay, expressed here this evening; and while I will not detain you with a description of the battery arrangements, still I would point out that six of the eight machine guns of the Atlanta are operated from within the superstructure. Those on the upper deck are not provided with fixed mounts. In fact, the battery is so arranged that the scheme of the essayist as to battery divisions appears practicable. It should not pass unnoticed also that the Atlanta is provided with an elaborate and complete system of speaking tubes arranged with special reference to the command of the battery and the supply of ammunition in action.

THE CHAIRMAN.—I think the essayist has every reason to be gratified at the manner in which his essay has been received; for it has attracted a great deal of attention. I wish now to submit a few remarks of my own, which will come in as a general review of the subject.

If the question that was propounded to the Institute had for its object the production of a definite system for "changes in organization and drill necessary to sail and fight effectively our war ships of latest type," I think the question was premature; if, however, it was intended as a note of preparation to put the Navy on the alert, and to direct the naval mind to prepare itself for what is coming by inquiry, it is very well, and our essayist has well performed his task. We are not sufficiently familiar with the ships to conclude definitely on changes in organization; we are not sufficiently familiar with the guns, carriages and implements to determine on changes in drill, or the number of men, even, needed to manipulate the batteries. We are dealing with unknown quantities, and we can lay down no rules until practice may develop the necessities. It is right, however, that the naval mind should be exercised on this matter in advance, and the result of the propounding of this question is most satisfactory in showing that the subject has the attention of many of our most thoughtful minds. The proof of this is shown in the number of essays sub-

mitted in response to the question—seven in all—a number, I think, larger than for some years preceding.

Not being in a position to lay down definite rules, our essayist has most liberally supplied us with suggestions apt for consideration when the time to apply them shall arrive, and there is an admirable thoroughness apparent in the manner in which he treats them. He certainly has proved himself guilty of the crime of earnestness, and has not hesitated to pose as a target for the shafts of criticism. He is right: this is a time of transition in the Navy, and old customs and traditions do not now obscure the merit of new ideas. Innovations are not necessarily condemned because they derange established routine; the spirit of progress permits a hearing to all. Some may be roughly handled in the clash of ideas, but the intelligent manner in which advances are made must lead us to the belief that sound judgment will control our decisions on all questions of change.

I think the reference made by Lieutenant Calkins to the necessity of increasing the complement of men for our new ships is worthy of consideration. It is very timely, too, and will apply to the old ships as well. All executive officers have of late years been at their wits' end to provide men for the performance of various duties, and this scarcity of men has led to a practice which Lieutenant Calkins objects to, and I agree with him, of calling all hands on every occasion of performance of any, even the most trifling, evolution. I endorse fully the suggestion to work by watches as much as the force will make it practicable. The number of the crew is needed to be increased at this time, even in our old ships, if only for working the secondary batteries that must be increased.

The idea of enlisting young men of native birth to the age of twenty-five years, irrespective of their knowledge of seamanship, allowing them to form a large proportion of the crew, is not new, and it is one that I have approved. To change the title of these men from landsman to volunteer or seaman cadet, or any other more appropriate, is, I think, a good idea. They should be on trial, as it were, for a short term, on duty in the North Atlantic Squadron, subject to discharge at any time if found undesirable, retained on good behavior, and encouraged by rewards if proving suitable and efficient. Our service is un-Americanized by only enlisting seamen. In spite of the higher pay and increased comforts, we do not now secure American sailors for the Navy, and the number of apprentices who re-enlist in the Navy is sadly small (the Brooklyn, lately gone into commission, had only six of them in her crew). The trial has not yet been made of shipping young men of twenty-five in large numbers, irrespective of their sea experience, for short terms, during which they can decide whether they will persevere in the profession or not. The knowledge that they were not bound for a long period would impose contentment even on those who concluded not to continue in the service. Although I am strongly in favor of a seafaring man learning his first lessons in a purely sailing vessel, and had hoped that the training service for boys would supply such for the Navy, I am forced to admit that the results do not meet my expectations. The young men of twenty-five years of age would commence their instruction in

ships where sails, ropes and spars occupy a secondary position; but their age and intelligence may compensate for what is wanting in primary instruction.

The subject of competition is well presented in the essay. It must be delayed until details are mastered, and it should not be reserved for ship against ship. It should be more encouraged in every ship. Working by watches will encourage it as watch against watch, and the different parts of the ship should compete with one another. The stringent application of this practice would logically lead to the abandonment of simultaneous crossing of royal yards and such-like evolutions, which are cited as illustrations of adherence to practices which militate against progress. It probably would need but the first plunge to reconcile us to such changes. The idea has been suggested before, but it stands a better chance now for the test of experiment. The adoption of such practices will show that the object of the exercise is achievement, not display. It would be in the same line of independence which we have assumed in the rig of some of our new ships, where we have asserted our preference for utility at the expense of conventional, seamanlike appearance. It may be that the time may come when the writer of the essay may be gratified even by having the "ceremonial of colors" divorced from "practical exercises in seamanship." The exercise that he proposes of four special rigs for harbor, sailing, steaming, and fighting is a useful addition to seamanship drills.

In relation to matters pertaining to action, whether with the battery, the company and battalion, or boat expeditions, the object of the essayist is to have the "division" as the basis of the organization. This effort is in the right direction. I think we will all agree to this: it is the decided tendency of the mind of the service. To apply this to battery drill, it is proposed to abolish the powder division as a separate organization, and to appoint men in each gun division to pass ammunition to their own guns. The assignment of men to a gun division is, of course, greater than is required to work the guns alone.

The division of force is made by setting off a certain number of men—petty officers, engineer's force, etc., as already assigned—and then arbitrarily dividing the remainder of the crew into equal divisions. Supposing the battery to be of such a character as to admit of this, the duties assigned to the navigator's division must also be made to provide the same number of men with occupation in action. I suppose this would be practicable by giving them some of the guns of the secondary battery.

Each division must be made up of similar material; petty officers, mechanics, cooks, and servants must be represented in each. This is specially the object to accommodate expeditions from the ship, that each company may find itself equipped for all parts of detached service. In serving the guns we shall find then the same class of men as now assigned to the duty of passing ammunition. They will be under the command of the officer commanding the division; this officer thus controls everything relating to his battery, including the supplies from the magazine and shell rooms. I think there is a good element in this proposition. The gun division is no longer dependent on another division controlled by separate authority: the officer of the gun division has in his own

hands the direction of every detail, and his responsibility is made more distinct. As a division officer I think I would like it: I would like to see the experiment tried. I recognize that there are men filling some stations who would not be attached to any division, as the gunner's mates in the magazines, the quarter-gunners at the shell rooms and armory, etc.; but this is a matter of detail that would be adjusted. It is the "runners" and shell passers who would have a distinct interest to subserve, each working for his own division, and competition would be introduced in a quarter where it has hitherto been unknown. These men would be exercised with their own gun division, and each one would become familiar with the character of the ammunition and the place where it is stowed—information which, under our present system, is limited to a very few men in the powder division, to whom the runners and shell passers look for guidance and direction. Breaking up this force of idlers into smaller bodies, separately instructed, will widen the scope of useful knowledge on matters relating to fighting needs, resulting in a more complete absorption of this force into the fighting organization of the ship. There can be no doubt that such training as these men will receive, under the proposed system, will make them more efficient as a reserved force when left on board to defend the ship during the absence in boats of a large contingent on distant expeditions. Their enforced familiarity with the gun division will fit them for doing good service with the battery.

I have said enough to show that I have been interested in the essay, and I do not know of any of the radical changes proposed that I would not be willing to subject to experiment, which, after all, must determine what our future organization is to be. I repeat that we are not yet familiar enough with our new ships and guns to lay down fixed rules for our future practice; the changes must grow with our experience. It is enough that thought is at work in this direction, and suggestions are in order. Our essayist has given much thought to the subject, and his suggestions are not only worthy of consideration, but many of them will, without doubt, be acted on. I think his paper is a valuable contribution to the literature of the Institute and to progress in the Navy.

NEWPORT BRANCH,

MAY 7, 1886.

Commander W. T. SAMPSON, U. S. N., in the Chair.

Captain A. R. YATES.—*Mr. Chairman and Gentlemen:*—There are some points I should like to mention regarding the retention of trained seamen in the Navy which are, I believe, of sufficient importance to be carefully considered in connection with the essay.

By reference to the new pay-table, it will be seen that the first-class petty officers of the seaman class receive about 50 per cent. less pay than those of the special

and artificer classes, although but one of each rate of the former class is allowed to any vessel, and there are of the latter classes sometimes two and more: as yeomen, ship's writers, schoolmasters of the special class, and machinists of the artificer class. No one can justly deny that the apprenticeship necessary to make a competent chief boatswain's mate, chief quartermaster, or chief gunner's mate is fully as long and difficult as that to make a machinist, and the qualities to be possessed by the former are rare and valuable. Further, these petty officers represent the seaman class, a calling essentially naval and seafaring, and the knowledge necessary to perform these requisite duties is obtained but at sea and in the Navy.

It is not surprising, with this fact of less pay, and consequently, in his opinion, less appreciation of the seaman class in the country before him, that the naval apprentice on completing his apprenticeship seeks a livelihood in other callings where more pay and greater comforts are obtained. He feels that he has been trained five or six years for a calling that can be followed but at sea and in the Navy, and the compensation he receives for this special knowledge is less than that received by those having a calling that can be followed afloat and ashore, and for which less preparation and knowledge is needed. While the pay of the special and artificer classes is not considered too much, it appears but just that that of the first-class petty officers of the seaman class, of whom there are but three in any ship, should be equal to it, and the pay of the other petty officers of this class, and the seamen themselves, should be more justly equalized with that of the other classes. It will not do to delay increasing the pay until there are competent men for these positions: inducements must be offered to make the apprentices render themselves proficient for these duties.

In this connection I would speak of the comforts of the enlisted men on board our war vessels. Wherein have they changed during the past fifty years? On the berth deck there are the traditional mess chest and jackstay. If men are allowed ditty boxes, or if their storm clothes and peajackets are stowed elsewhere than surreptitiously in nettings and forbidden places where they can be obtained without permission from the officer of the deck, it is owing to the consideration of the commanding or executive officer, and not to any regulation or provision made by the service or by the naval constructors, who, having never been to sea in a war vessel, are necessarily ignorant of many of the essential requirements for the comforts of the men. In fact, the encroachments of the officers' quarters, store-rooms, electrical plant, and ventilating apparatus, have left the hammock swinger barely the old regulation space of 14 inches—the same distance between hooks that was allowed in the old sailing ships when but one watch of hammocks was down at a time.

The essayist is correct in saying that thus far the numerical results of the present training system are not satisfactory. But it is believed that it is not so much the fault of the system as it is in the treatment the apprentice receives after he leaves the training ships, and the consequent poor encouragements offered him to remain in the service. In a country where the working classes are so generally well and comfortably housed, it is strange that in its naval

vessels the seamen have fewer comforts and conveniences than in those of the great European powers. It is to be hoped that in our new cruisers reasonable accommodations will be afforded the crew—not simply those in which they can exist, but those in which they can do so comfortably. Until this is done, no training system will be successful, for it will fail to retain the able seamen requisite for the efficient manning of the modern man-of-war.

Commander T. F. JEWELL.—*Mr. Chairman and Gentlemen:*—While approving in the main the recommendations of the essay, I am compelled to differ with the writer on several points. In the first place, I deprecate any interference with the training system. That system is now, after many years of effort, an organized system, and though the results are not as yet so satisfactory as we might wish for, I am certain that any curtailment would be a step backwards. The difficulty of obtaining efficient men in the service is not so much in the training system as in the retaining of the men after they have served their apprenticeship. As a matter of fact, the men so trained find that their training has qualified them for positions outside of the service more profitable than any they could hope to attain in the service. May not the real trouble be found by a comparison of the rates of pay of the several classes of enlisted men as given in the pay-table? By all means let us add to the number of efficient men in the service by enlisting and training young men in cruising ships, if it can be done; but does not experience tell us that this method will not give us the men we want? And I think you will agree with me that the man who is first of all a good, smart seaman is a handy man to have around for almost any kind of work.

I do not agree with the essayist in his suggestion that the numerical strength of the several divisions should be equal. As many men should be assigned to each division as are required to perform the duties of that division, and no more. The idea of the essayist seems to be that there should be the same close relationship between the men composing the division and the division officer as subsists between a captain and his company in the Army. I agree that a more direct and personal supervision of the men of the division by the division officers than now obtains as a rule, would be desirable; but that the number of men constituting a division should be determined by the desirability of giving each division officer a comfortable infantry company, I deny. Nor would I abolish the powder division as at present constituted. The present organization of the powder division makes available at general quarters and in action a large number of men who would not be available for service at the guns. To turn over the duties of this division to squads detailed from the gun divisions, away from the personal supervision of their division officers, would, in my opinion, be unwise. Let me add that a well-organized and thoroughly drilled powder division is not absolutely unknown in the service.

I am glad to see that the essayist lays so much stress on the necessity of better instruction in pointing and firing. It has always seemed to me that our practice in this respect was superficial and ineffective. Some method should be devised by which aiming and firing may be taught so that the instructor would be able to determine whether his men were profiting by the instruction.

I confess that I have never been able to satisfy myself on this point. A good shot at a target—as target practice is usually conducted—is as likely to be an accident as to be the result of proper instruction.

There is one point with regard to reorganization that I should have been glad to see touched upon in the essay. This is the era in which the armament of a vessel of war is of the most complex character, and in which expert knowledge is of the utmost importance. The high-powered ordnance, machine guns, auto-mobile torpedoes, dynamo-machines, electric-light circuits, both for search lights and for interior lighting, the care and use of gun-cotton and other high explosives, to say nothing of the application of electricity to the training, pointing, and firing of guns, will demand the services of a class of officers with much more advanced attainments than are possessed by a majority of the officers of the service at present. As it is now, it is usually a disadvantage to an officer to know much outside the most ordinary routine of his profession, for if he is found to be proficient in any other class of work, he has not only the routine work to do, but the other work as well. I should like to see attached to every vessel an ordnance officer whose principal duty should be the supervision and care of the armament of the vessel, but who might command a torpedo division, or give instruction in torpedo service to men detailed from other divisions, and who should be relieved from standing watch and from duty with gun divisions. If such a position is created, it should be filled only by officers who have the proper qualifications ; who have pursued a course of instruction in the Ordnance Shops at Washington, at the Proving Ground, and at the Torpedo Station.

The incentive to preparation for these duties would be the honor and distinction attached to the office. Mere lineal rank should not interfere with the assignment of officers to this duty, except that it should be confined to the grades below lieutenant-commander. The navigator, who is now the ordnance officer, if he properly performs the duties assigned to him as navigator, is already overburdened with work, and his rank alone is not a sufficient qualification for the position of ordnance officer.

THE CHAIRMAN.—The author in his introduction very properly attributes the promise of improvement in the character of our ships to the work of the successive advisory boards. To whomever may be due the idea of the Naval Advisory Board, to him we owe a debt of gratitude. The old plan of leaving the designs and interior arrangements of our ships to the Bureau of Construction resulted in constantly reproducing the same type of vessel, and doubtless would continue to furnish equally unsatisfactory results. Improvements would be adopted only after they had been elsewhere long in use, and even after they had been superseded by greater improvements, thus leaving us always a long way to the rear in the march of improvement.

Even if our constructing and engineering departments were always managed by men the most able in their profession, still it would be too much to expect them to keep pace with the changes in the many branches of science and in the art of naval warfare which are absolutely necessary to the proper designing of war ships. There is probably to-day no product of the hand of man which

embodies the application of more scientific and mechanical principles than a modern man-of-war. There is no more complicated machine, nor one which demands so much skill for its proper control and use.

This vastly increased complexity alone is sufficient reason why the constructor and engineer should, in designing new ships, call in the aid of those who must decide upon the armament and command the ship when she is completed. It is needless to say that, to command properly such a complicated machine, her construction and capabilities must be thoroughly understood, so that a double advantage is secured by associating the constructor, engineer, and military officer in producing the designs of our ships. We get, in the first place, more efficient ships, and those who are to command them acquire a knowledge of their capabilities of offense and defense which could not be so well acquired in any other way. From my limited experience in such matters, I am of opinion that in future our ships, and even our torpedo boats, should be designed by such a mixed board.

As a matter of naval policy, it would be, I think, a great advantage to the service, particularly at this time, when we are building up a new Navy from the beginning, if the Navy Department would prepare plans and specifications in anticipation of appropriations. Before Congress can make an appropriation with any degree of confidence, it must have the opinions of naval experts, or those who consider themselves such, as to the needs of the naval service in regard to ships. If an opinion is not forthcoming from the proper authority, there are always plenty of people in and out of the service who have their pet ideas of what a ship ought to be—too often one-sided—which are likely to be the basis for an appropriation for building ships. If, however, the Navy Department would submit the whole question of the increase of the Navy to a properly constituted board, and have designs prepared, so that when Congress is inclined to make an appropriation, perfectly definite information can be submitted for its guidance, such a course would create in the Congressional mind such a degree of confidence in the administration of naval affairs as, I venture to say, has never existed in this matter. To keep pace with the developments of naval science in other countries; to be prepared to take advantage of all progress made by them; to be ready to present to Congress, whenever it requires them or can be induced to increase the naval establishment, such plans as would, at the time, embrace the latest and most improved designs—all this would furnish continuous occupation for an advisory board.

Concerning the complement of a ship, I venture to suggest that the number of men and officers required to develop the full fighting capacity of the vessel should decide the question. A vessel of given displacement can mount a certain battery the character of which is determined according to some theory as to her future duties. If she is a cruiser, she would not be expected to contend with armored ships or forts; consequently the calibre of her guns should not be great. If she is to be a ram, she should have the heaviest practicable fire directly ahead, etc. Now, whatever may be the character or design of her armament, the crew assigned to her should be capable of developing her maximum power of offense and defense. Any increase beyond this point must detract

from her efficiency, because it must increase the weights, besides increasing the chance of casualties among the crew. The complement thus determined may or may not occupy all the berthing space in the ship. The same general rule should determine the number of officers. In this connection, it may be stated that for equal weights of armament the modern man-of-war requires a greater number of officers than vessels of older types, because the guns and their attachments are much more complicated than formerly. Each gun requires the close supervision of an officer, or, what comes to the same thing, the supervision of some man who thoroughly understands the use of the arm. When to this is added the complicated mechanism of torpedoes and search lights, and when we give proper weight to the fact that the movements of a modern man-of-war in action will be executed with the greatest celerity, it becomes evident that each part, combination of parts, and the whole ship must be supervised in the most rigid manner. For the same reasons, the education of our seamen must be vastly superior in some directions to what was required when sailing vessels and smooth-bores were the fighting tools. To go a little more into detail, it will be necessary to have an officer on board of each modern ship who shall be qualified to care for the batteries and torpedo outfits of the ship. He may be called the ordnance officer or the torpedo officer, but he should be appointed to the position because of his acquaintance with those weapons, and he should be responsible for the proper condition of them at all times. He should not have to stand a watch except at sea. These duties have heretofore been performed by the gunner under the general supervision of the navigator. This must be changed in our new ships if we wish to secure the maximum efficiency. The duty must have the exclusive attention of a trained officer.

We may say, then, in general terms, that the progress in naval architecture and high-power guns, with the greatly increased number of labor-saving devices applied in all parts of the ship, demands an increase in the number of officers, and a probable decrease in the number of men as compared with the same weight of battery of smooth-bores. When we have adopted some general scheme of this sort to determine the complement of the ship, all other duties to be performed must subordinate themselves to it. The engineer's force should be ample, and I am decidedly of the opinion that they should be instructed in their important duties; especially is such instruction necessary in the case of the firemen. We should not be annoyed by such variations in the speed of our ships under steam as are constantly occasioned by changing from one watch of firemen to another. The nicer adjustment of the capacity of boilers to the engines, and the use of forced draught, demand greater skill and care on the part of the firemen.

NORFOLK BRANCH.

MAY 26, 1886.

Captain GEO. BROWN, U. S. N., in the Chair.

The Secretary having read the essay, it was decided to discuss that part relating to the Marine Corps first.

Major JAMES FORNEY, U. S. M. C.—*Mr. Chairman and Gentlemen:*—I think that the best way to reorganize the marines would be to give them regimental formations, provided that the present strength of the Marine Corps, which is now only 2000 enlisted men, could be increased. Also, that three large depots should be established at Mare Island, Philadelphia, and Norfolk, where at least 500 men should be stationed, commanded by the requisite number of field and company officers. A summer camp of the same number of men would also be of great advantage.

The essay mentioned that the marines are not armed with the best rifles. I would state that they all have new rifles, calibre 45, No. of 1884. It has been demonstrated that officers are better adapted to command the guards of ships than non-commissioned officers. The paragraph in regard to there being only two officers in a squadron, and these should be graduates from Annapolis, is hardly feasible; for what use are the other officers to be put to? Besides, many of the civil appointments are equally as well educated, and as efficient officers as the graduates. Many of the generals of the Army are from civil life. The marine officers should be graduates from West Point rather than from Annapolis.

In connection with the marines working the guns on board ship, it has been the general custom for them to do so. I myself commanded a division of guns on the Brooklyn, Hartford, and Pensacola. I consider that it would be very injurious for the marine to lose *esprit du corps* as a soldier, and to make him more of a sailor than he really is now; for in the ordinary duties of a ship they pull and haul on the ropes and keep the regular watch; they protect public property, and all prisoners of war, that at times outnumber the crew; while ashore they guard and protect the navy yards, with their immense amount of public property, and are always ready for emergencies in adjunct cities, and frequently mobs in New York, Maryland, and other States have been quelled by the marines from the navy yards.

Lieutenant R. M. G. BROWN.—*Mr. Chairman and Gentlemen:*—I cannot agree with the essayist in regard to reducing the guards of our vessels of war. I would favor larger marine guards, and would have them drill at the great-guns and all rapid-firing guns. They should of course have the best magazine small-arms, and be our main dependence for landing expeditions. By having large guards, the ships of our important squadrons would be able to land 500 men—sufficient for all ordinary purposes. Another advantage of large guards, is that it would utilize the 2000 men in the Marine Corps, and allow of smaller complements of seamen. We would thus be enabled to keep more ships in commission; and what the Navy needs at present is more ships in commission.

First Lieutenant L. W. T. WALLER, U. S. M. C.—*Mr. Chairman and Gentlemen*:—I think the marines should be placed in charge of the machine guns on board of ships; and, if necessary to instruct them at the other guns, that they be drilled under the marine officers. In landing, the marines could act as infantry, and as light artillery with Gatling and 3-inch breech-loading rifles. A central depot should be established.* Details should be made from time to time for guarding navy yards. The depot should be made a school of instruction for officers and men; the use and care of rapid-firing, light and heavy guns, submarine mines, etc., to be a part of the instructions. Men should enlist for five years, and have regimental formation, and should be sent to sea under their own officers. The American marines are as capable as the English, and the system of marine artillery works well in that service. The corps should be increased by 500 additional men.

Commander P. H. COOPER.—*Mr. Chairman and Gentlemen*:—I do not infer from my reading of the essay that the author intends to criticise the efficiency and value of the marines. His idea looks towards the manning of our future ships with a homogeneous body of men, if possible. Special training being needed for the secondary batteries, and there being no place on board ship for any but a force that will fight the ship, no room for a body trained especially as the nucleus of a landing party, it seems to me that the essayist on this ground minimizes the marine guards.

Granted, however, that the marines can receive preliminary drills and instructions with machine and rapid-firing guns, fitting them to be a body of marine artillerists, I have no doubt that the universal opinion would be that no more valuable and reliable adjunct to the fighting complement of the ship could be had.

THE CHAIRMAN.—During the war the marines were given great-guns to serve and were commanded by their own officers; they served those guns as well as the blue-jackets; and there is no reason why the marines should not be instructed on shore in the use of machine guns and on board ship at modern great-guns and carriages. When it becomes necessary to land a small force from a single ship, or a larger force from a squadron, the marines are better prepared, from previous training, to perform duty on shore than the blue-jackets.

There should, in my opinion, be a marine officer in every ship having a guard, so that in the event of the whole force of marines being landed, there would be enough officers to organize properly one or more companies. I have never known a commanding officer to complain of having too many marines under his command.

The Secretary then read that part of the essay relating to the training system.

Lieutenant BROWN.—*Mr. Chairman and Gentlemen*:—I consider the training system a great benefit to the service, and would regret to see the system

* Craney Island, Va., is a central position, and would be good on account of the climate.

crippled. The supposition of the essayist that only a few return to the service is no reason for abolishing the system. If only ten per cent. return, I should advocate the system. The apprentices have to serve until twenty-one, and there are several hundred now serving on regular men-of-war after having completed a course on the training ships.

It is a question whether the unpopularity of the service is not greatly due to the constant drilling necessary in order to make a sailor "jack-of-all-trades." It is certainly desirable to retain the best graduates from the training ships in the service. To do this, the service must be made more attractive. We should remember that sailors, like all laboring men, are chiefly influenced by the relation between the hours of work required and the pay earned.

I think it is generally complained of by the officers of the training ships that the petty officers of the ships are not graduates from the training school. Many of the petty officers of these ships are men whose characters are bad. If the best graduates were retained as petty officers, it would remedy this evil.

Captain GEO. C. REMEY.—*Mr. Chairman and Gentlemen:*—I think the present apprentice system should be continued, but modified from time to time in its formal administration as experience may prove advisable. After serving a length of time, say six months or a year, if it be apparent that an apprentice has no aptitude for the service, he should be discharged in a home port. I would also adopt the plan of enlisting men under twenty-five years for general service. These men should also be liable to discharge at the end of six months, if found unfit for service. With the exception of the recommendation of the essayist to put the present training system on a reduced basis, I agree mainly with his views, and feel that he is entitled to the thanks of the service for his vigorous essay.

Lieutenant-Commander E. S. HOUSTON.—*Mr. Chairman and Gentlemen:*—I am of the opinion that the present system should be continued, notwithstanding the somewhat discouraging showing of actual numbers permanently added to the service. This result comes from a state of affairs peculiar to the present conditions of American life—conditions which will gradually change for the better in the future; and while the service may not now get such benefit for the outlay, it undoubtedly will in the end and during a war. Keeping this in view, I favor not only its continuance, but its expansion by Congress as a wise national policy. Regarding its internal management, I think we may safely leave that in the hands of those having it in charge, as in this, as with most questions connected with the service, it is not the want of wise measures so much as it is the lack of means to carry them into effect.

Lieutenant-Commander MARTHON.—*Mr. Chairman and Gentlemen:*—In my opinion the training squadron should be continued, even enlarged. The small per cent. of re-enlistments does not by any means remove these trained men from a seafaring life. A large number of them ship in the merchant service, where they are able to reach the positions of mates. Others will, after a time, return to the naval service. Others, though giving up sea life, are always available in time of war to man our coast and harbor vessels.

The system in my opinion turns out able, intelligent, sober, and healthy men, and a more reliable class than those men who are picked up at home or abroad, and who, being only desirous of a living and good pay for a short time, soon leave the service and country forever. The greater part of our crews on foreign stations are of this nature, really "birds of passage," without character and, I might say, without country. The apprentices are all Americans, and extremely loyal to their flag. Therefore, in my opinion, the system should be continued. The petty officers of the training squadrons should be taken from the ablest of the graduates, as suggested by Lieutenant Brown, not only as an encouragement, but as a just reward for their merits.

These boys on cruising vessels I think are better informed in regard to great-guns, shells, small-arms, infantry, and battalion drills than any of the old men on board. This very great advantage of knowing the internal rules and stations of a man-of-war, when a number of them are transferred to a vessel, saves men and officers a vast deal of trouble in the beginning of a cruise, as well as when on a foreign station. The naval education which they receive during their apprenticeship makes them good, reliable citizens, with a greater knowledge of what the outside world is like, and a stronger love for their own country, which they will be ever ready to defend in case of need.

THE CHAIRMAN.—While it is desirable to have apprentices re-enlist and remain in the service after reaching their majority, the fact that only a small percentage do continue in the service is no evidence that the present system is a failure. The early training of a boy on board the training ships and in cruising vessels will never be forgotten by the man, and although he may find a more agreeable occupation on shore, we can rely on obtaining his service in time of war, and therefore the cost of his training is not thrown away. In civil life, the man who has had three or four years of discipline and training in the service as an apprentice will be a better and a more useful citizen in the community in which he resides, and the Government will not have thrown away the money expended in his education.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HONORABLY MENTIONED.

MOTTO:

The result of all naval administration and effort finds its expression in good organization and thorough drill on board of suitable ships.

WHAT CHANGES IN ORGANIZATION AND DRILL ARE NECESSARY TO SAIL AND FIGHT MOST EFFECTIVELY OUR WAR SHIPS OF THE LATEST TYPE?

BY ENSIGN W. L. RODGERS, U. S. N.

Organization and drill in the Navy depend on the laws for the Navy and the customs of the service. Customs being flexible, we naturally find them conforming to the needs of the service almost as closely as the laws will permit, and, therefore, without legislation we may not hope for any decided improvement.

The production of efficient men-of-war being the sole object of a navy, it is apparent that the Navy Department as headquarters, and its organization, demand the first consideration.

The present system of departmental organization and administration began in 1842, when the Board of Navy Commissioners was abolished. At that date the modern changes in naval science had just begun with the tentative introduction of steam on board the Princeton, but the great revolution in the near future was unforeseen, and the new organization, while good, was only equal to dealing with the existing problems. Since that time our native-born seafaring population has disappeared, and all naval science has made the most wonderful progress. To meet these great and varied changes and the greatly increased duties entailed by them, the bureaus of the Navy Department have been multiplied, and the individual bureaus have added function to function; but they have grown only by accretion: never

in these forty years has there been a general survey of the field of naval affairs and a corresponding change in the organization and distribution of duties in the Navy Department.* As a result, each bureau has endeavored to become independent of all the others, relying entirely upon its own resources, and caring little for the demands and necessities of the others, while it has gathered to itself the most incongruous duties, and cares only for the fitting out of ships. After ships are commissioned, there is no one in the department who is interested in their efficiency.

If we turn to the reflection of the bureau system on board ship, we find the bureaus each represented there by an officer charged with the duties and stores of the corresponding bureau, and with certain men more or less under his control; he is subject only to the captain and not to the executive officer; so that there is one system of control for the majority of the officers and men, and several systems for the minority.

The direction and supervision of drills and of discipline, as well as other executive functions, are distributed among the various bureaus, instead of being under one; and as bureaus are organized and fitted for office-work, they exercise their control only by means of quarterly returns, so that if commanding officers are careful about red tape, they may carry out drills or obey circular orders very much at their own discretion.

The duties of the Navy Department are twofold. First are the civil duties, including the building and maintenance of ships and navy yards, and the manufacture and purchase of equipments and stores; then there are the military duties, which embrace the recruitment, discipline, instruction, and drill of the officers and men of the Navy, both ashore and afloat, the control of the movements of all vessels, and the direction of fleet operations. These two classes of business have nothing in common, and should be entirely distinct from each other, with a "director of construction" at the head of the first, and a "chief of staff" over the other. The bureaus should be retained as administrative units, but altogether under the authority of the "director" and "chief of staff," and with a redistribution of duties, so that all those of any one bureau would be naturally related. Under the "director of construction" should be the bureaus of supplies, of construction and engineering, of ordnance, and of yards and docks. The first bureau should be charged with the purchase and care of

* The above was written before the appearance of the Secretary's report.

all stores, materials, and supplies for use in navy yards and in the fleet, and should issue them upon requisition. Under the "chief of staff" should be all the military duties before mentioned, and in addition the records of officers and men, details, issue of general orders, circulars and drill manuals, inspection duties of all kinds, and the Office of Naval Intelligence. Inspection duties are among the most important in all well-managed military organizations, and are on a very inefficient footing in our Navy. The officers detailed for inspection should be the eyes and ears of the Department in the service at large. All records and work in the yards, and the entire economy of ships, should always be open to their examination; and besides reporting upon the condition of what they see, they should be expected to suggest improvements wherever called for, thus acting as a spur to the rest of the Navy. These officers should compose all boards for the examination of technical matters. The Secretary would thus be left the general control of the Navy unembarrassed by technical details, retaining as his special province the relations with the President and Congress, and the complete control of all financial matters. The Secretary has recently taken steps to bring the finances more under his own control, and the result will doubtless be most excellent.

As the Secretary is allowed by law to distribute the work of the Department among the bureaus, there would be little difficulty in making any arrangement that he pleases, were it not that the bureaus and the corps of their chiefs are defined by law, and that the annual appropriations are made for each bureau separately. He has, however, very wide discretion and authority in the matter.

The Corps of Officers.

Now to consider the officers of the Navy. In intelligence and natural abilities, they compare very favorably with those of other nations, but they are heavily handicapped in many respects. The young officer upon graduation finds himself at the foot of the long ladder of promotion, with the certainty that no good conduct or professional ability will advance him out of his turn, and with the equal certainty that nothing but the grossest misconduct can retard him. The general opinion of his brother officers is not of importance to him, for they cannot reward or punish him; the examinations that he passes are mere repetitions of those at graduation; and so he goes

on to the highest grades of the service, relying more on physical than on professional and moral qualities, and with only the satisfaction of duty well performed as an incentive to faithfulness and zeal. There are many officers in the service who are fully equal to the duties of subordinate grades, yet who have not the ability to fill the higher grades with credit. It is desirable to retain these men in the service, yet there is no reason why the Government should place them in situations whose requirements are beyond them. In every other walk in life a man's success is proportioned to his ability, but in the Navy the rigid system of promotion results in a frequent lack of cheerfulness and exactitude in obeying routine orders and carrying out routine duties; this becomes apparent even to civilians in the careless mode of wearing the uniform.

There was submitted to the last Congress a system of promotion which permitted undesirable officers to be retired on reaching the rank of commander or captain. This plan, combined with a rigid system of progressive examinations, would be of benefit to the service, but the system in practice by foreign nations is preferable. There we find that a large number of promotions take place by seniority, but the government reserves to itself the right to select specially promising officers and promote them out of their turn. Those chosen are usually not advanced very much at a time; must pass rigid examinations, and have certain records of conduct and service, so that none but deserving men are advanced, while those remaining in the lower ranks are retired by age limitations. In this way, as in civil life, a prize is held out for zeal, good conduct, and ability, and the country gets the benefit of capable service.

There are two arguments advanced against this scheme. However the sustainers of the first objection may present it, it amounts to this: "If such a scheme becomes law, A. B. will be promoted over us." In most cases the obvious answer is that such a result would be very desirable. But many officers, while acknowledging the advantages of such a plan, doubt whether it could be put in practice and carried out with substantial justice. The general opinion of the service, together with examinations, would probably be weighty enough to prevent the selection of unworthy or undeserving candidates; this is as far as justice can go, and is all that is desirable in this case. What is necessary is the assurance that officers shall rise in some degree according to their merit, so that men of inferior ability shall retire early in the lower ranks by age limitation, while better men rise

proportionately higher. The present system, however, may be called unjust, for now rank is no measure of ability and merit; the proposed system tends to make it so in a general and limited way. Much improvement can be accomplished in this direction without legislation. The primary duty of every officer in the Navy is on board a seagoing ship, but this is not recognized in any official way by the Department, and shore stations are naturally preferred. Officers are now sent to sea by the roster, and no matter what their qualities for command may be, they are sure of getting vessels. Before the war the *personnel* of the Navy was in very much the same condition that it now is, and as a remedy the Department adopted the policy of entrusting ships only to the best men, allowing those who were not fit for sea duty to remain on shore. This was an expensive method of manning the fleet, but it set a premium on professional merit, and procured the best men by giving to officers of all grades higher commands than their rank entitled them to hold.

A reason why incompetent officers so readily pass their examinations is that, although ample data for rejecting them exist in the Department, it is very hard to collect it in any given case; and when officers are questioned regarding candidates for promotion, their good nature sometimes permits them to give official answers very different from their freely expressed real opinions. The remedy is to keep an index in which to enter under each officer's name every article of information and official reference regarding him as it comes into the Department. Moreover, it sometimes happens that newspapers make scandalous charges against officers of which no notice is taken, because it is no one's business to do so. It should be the duty of the Judge Advocate-General to investigate such charges without further notice, and deny them in the name of the Department, for the credit of the service, if they be false, or bring the offenders to trial if they be true.

A post-graduate school, where officers may practise the latest novelties in naval science and perfect themselves in the theory of the various specialties, is an absolute necessity. The study of the higher branches of the profession should be deferred until after several years at sea, when it would be more profitable than under the present system; for it is only from the careful study on shore of the experience gained at sea that improvement is derived. For such a school there can be no place so fit as Annapolis, which already possesses all the advantages of a complete and well-organized educational establishment.

The primary duty of every naval officer is to handle and fight his ship well, and, in the organization of the Navy, combatant efficiency should be the sole consideration. Incidentally we find officers and men performing divers auxiliary duties in time of peace, but this is merely to utilize their abilities, and should be considered as of no weight in influencing the organization of the service. Naval officers are rather arbitrarily divided into two classes, the line and the staff, staff officers being assumed to be non-combatants, and friction arises between the two classes from the false position in which the engineer corps is placed. This corps, of later origin than the other staff corps, has become of great, though not fully recognized, importance, and has received an education beyond the position that it holds; and while chafing under this state of affairs, it has found some support from the other staff corps.

In examining the present status of engineers, we find that they have every official and social recognition except that of military command, when the truth is that they are combatants in every sense of the word, and should be recognized as such. The education of engineers is a most thorough one, embracing designing and building engines, as well as the practical duties of the engine room. But the primary duties of all naval officers are on board their ships, and therefore, when engineers are assigned to designing duties, they are not as efficient as those who do nothing else. At sea, however, our engineers, being conscious of education and attainments above the duties there assigned them, have introduced machinists on board ship. So we have a poor class of machinists, because they are not responsible nor trusted, and the engineers complain that they are unreliable when placed in charge of the engine-room watch. It is not sufficiently recognized that every man-of-war is one homogeneous machine, and that, therefore, all officers on board should belong to one corps, all finally rising to command and acquainted with all the duties called for on shipboard, but each devoting himself to the study of one of the various specialties of his profession. The present system of special corps leads to the absurd conclusion that if a lieutenant and engineer go out in a torpedo boat and either is disabled, the survivor can do nothing but surrender.

The law of August 5, 1882, was a step towards the solution of this question, in making all cadets follow the same course at Annapolis and choose their corps after two years at sea. To complete the solution, the engineer corps should be abolished by absorbing all the

assistant engineers and as many as possible of the passed assistants in the line, leaving the rest to perform their present duties until retired. Such an increase of subordinate officers would be an additional reason for promotion by selection, in order to prevent officers from passing through the upper grades of the service in a very few years. By this plan the engineer division would be placed under one or more combatant officers, who would have charge of the machinery and engineer force. Engine-room watch and the immediate charge of engine-room work would then fall on a trustworthy class of machinists similar to locomotive engineers, who would be attracted by the increased responsibility and by a well-defined position with light work. There is no occasion on board ship for the designing and constructing talents of the engineer corps, because large shops are needed as a field for them, and if a ship is so badly injured as to need anything more than a temporary makeshift, she must always go into port. All this part of the present duties of the engineer corps—namely, engine-building—should be performed by a small corps of constructors, who should never go to sea, but be always employed on shore. This corps should design and build the hulls as well as the machinery, and as naval construction is different from ordinary ship-building and requires special training, this corps has every claim to a place on the Navy Register.

As for the paymasters, their duties consist in caring for and issuing the stores of the Bureau of Provisions and Clothing, and in acting as treasurer and accountant for the ship and crew. Here is nothing that any careful, honest man cannot do with the ample time at his disposal on shipboard. Indeed, the Navy Regulations provide that line officers may act as paymasters upon occasion. Additions to the pay corps should therefore be stopped, and all its duties be performed by line officers. The object gained would be the substitution of combatant officers for a corps of non-combatants, who do not add to the fighting efficiency of the service. Chaplains should be commissioned for each cruise, not permanently. With regard to the other corps borne on the Navy Register (surgeons excepted), as they do not go to sea, and may be recruited from civil life in any number and at any time, there is no reason why they should appear as naval officers enjoying privileges which are granted to officers as inducements to sever their relations with civil life. After careful consideration, the plan of having only one corps in the Navy does not seem to ask for too much from individuals, for it does not require officers to

be perfect in all branches. It is the system which was adopted by the Indian Army when the conclusion of the Sepoy mutiny called for a complete reorganization. There the cavalry, infantry, and staff officers all belong to one corps called the General Staff, and officers are detailed to various duties for a term of years, any one being liable to serve in diplomatic, civil, military, and engineering capacities, according to his abilities and the needs of the service. In the European armies, too, the best officers are required to serve in other corps than their own.

The chief difficulty in the proposed change would arise from the consolidation of the line and engineers, but it would not prove a substantial one. Line officers now know little about engineers' duties, because they have nothing to do with them until they reach command, but with the proposed change there would soon be a class of young officers giving special attention to the engines and equal to all their duties in that line. Indeed, at the present time, naval cadets only a few months from Annapolis, and ensigns, are frequently trusted with the charge of the engines under way, and perform all their duties both on deck and below with credit. This change would not prevent the development of specialties, for on board ship a man has not great opportunities for study: his duty there is to train and educate his men and obtain a practical knowledge of his profession. The specialist on board ship, who cannot go beyond his specialty, takes the place of a better man. On shore, however, in the various fields of work now occupied by officers of the Navy, there would be abundant opportunity for the study of the profession and the development of specialties, and every one should be encouraged to follow his taste in this matter.

The Corps of Enlisted Men.

The class of enlisted men now serving in the Navy is far from a satisfactory one. There are many foreigners, who ship because they can send money home periodically. The country could not expect their service in time of war; some of them can barely speak English, and most of them care nothing for the flag and take no interest in the efficiency of the ship. Then the term of service is so short that a ship cannot make a three-years' cruise without renewing the greater part of her crew, to the great detriment of efficiency. Finally, such is the anxiety to obtain men that enlistments are permitted and even

desired on board seagoing ships, where recruits frequently receive no proper training, but are put at their stations a day or two after shipping, and sometimes learn their duties by natural intelligence, but more frequently at the expense of the other men's drill and efficiency. The enlistments which are made abroad are of a very poor class, for they are usually of foreigners, or of worthless Americans who make use of the Navy as a temporary convenience, with the intention of early desertion. The Marine Corps compares most favorably with the Navy in these respects: the long term of enlistment enables a guard to make a three-years' cruise without many changes and to join the ship in an efficient condition, and the habit of forbidding all enlistments on shipboard raises the standard of recruits. With regard to petty officers, there is no such class in the Navy. To be sure, there are men holding the ratings, but they know nothing but seamanship, and not always that; are without authority, and command no respect.

To supply all deficiencies in our enlisted men, we should adopt the English system of recruiting and manning the Navy. We can draw few hints regarding this matter from other European navies, because they depend on compulsory service; but England relies on voluntary service, and with similar laws, customs, and naval usage to ours, her system is perfectly adapted to this country, and by adopting it we would find ourselves in possession of a practical method which has given England, though with her merchant service largely manned by foreigners, a navy manned by sober, self-respecting, native-born Englishmen, of sufficient intelligence and education to perform their duties well and furnish out of their number a class of reliable petty officers who are thoroughly respected and obeyed by the crew. The English system enlists boys at about sixteen years of age, before they settle down to trades, and, after a preliminary training, they serve twenty years in two enlistments, counting time from the age of eighteen. Those serving out both enlistments have pensions proportional to their latest pay while in active service. It is noticeable that of late years the question of State responsibility for the employment of honorably discharged soldiers and sailors has been much agitated in England. The men have given the best years of their lives to the Government, and in so doing have sacrificed their local connections, making it difficult for them to find employment upon discharge, although their general intelligence and habits of discipline render them particularly well suited for many positions. Under these cir-

cumstances, it is urged that the Government owes it to them to make some endeavor either to provide work for them, or by recommendations to obtain them work elsewhere. At the same time it is fully recognized that they cannot be allowed to exclude others from employment, as that would inevitably result in poor work and consequent failure of the plan.

In our service the pecuniary position of enlisted men is a hard one, and keeps away many good men in not allowing them to receive their pay except as the captain permits. There is no reason why men's pay should not be as completely at their disposal as that of officers. The present system of wages also is bad in that the pay of each rate is fixed, with a dollar a month increase for each re-enlistment. As the number of men of each rate is fixed for each ship, this plan does not offer sufficient inducement to good behavior and zeal. A better system would be to offer a small fixed pay of about ten dollars a month, with a series of supplements for proficiency in ship's work and in each of the various drills, with large supplements for good conduct. This would be a direct incentive to effort in any direction. The maximum supplement for any branch should be such as to make the desired number take it up. The lower grades of supplements should be readily obtained, but as a man's proficiency increases he should find it harder to obtain the next greater supplement. The supplement for good conduct should not be affected by petty offenses, but, once reduced, it should be hard to increase it again. Petty officers should receive an additional supplement proportional to the responsibilities they incur and the duties they actually perform.

A few words may be said here of warrant officers. They occupy a somewhat anomalous position in the service, for vessels without them do not feel the lack of them. In fact, it is apparent that the only use of the corps is to afford an opportunity of promoting deserving petty officers, and it is unnecessary to enlarge upon the poor economy of maintaining a body of men who are of no direct service to the country. The proper thing to do for the petty officers is to improve their position as such. At the same time, it must be recognized that promotion can never be closed against real merit, and that there must always be admission to the corps of officers for those seamen who deserve it. They can never be numerous, for the advantages of a fine education are necessary to make good officers, and few enlisted men could ever merit commissions. Even those obtaining them would retire early by age limitations, except in the rarest instances.

Organization of Officers on Board Ship.

We now have to consider organization on board ship; and first, of the officers.

There should be only one officers' mess, as in the Army, where the plan works well. By this means a number of non-combatants as officers' servants would be saved, the mess expenses would be lighter, the larger size of the mess would render it easier to maintain that general good feeling which is sometimes lost towards the end of a long cruise, the younger officers would benefit by association with their elders; finally, it would be easier to perform those social duties which are now frequently neglected. The captain should belong to the wardroom mess, thus saving a cook and steward, but should dine in his cabin.

As was explained before, all the officers of a ship except surgeons should be combatants, ready to perform any service that may be required on board. The captain should assign each officer to his division, consulting his wishes if possible, and no officer should be permitted to change his division during the cruise. In case of a vacancy occurring, the relief officer should take the vacant division without regard to seniority. The authority and responsibility of all divisional officers should be increased. They should keep the accounts of their divisions and prepare all requisitions, clothing and small-store bills, thus performing much of the work which now falls on the paymaster. They should be consulted about the rating and assignment of petty officers to their respective divisions, and should have control of their men's privileges, subject to the captain and executive officer. Whenever a man is brought to the mast, his divisional officer should be present as his counsel, to call attention to his previous record, or help him in any other way possible. In general, men should go to their divisional officers where they now go to the executive officer. This would in no way diminish the latter's authority, but, by associating the divisions more closely with their lieutenants, it would increase his control over both the officers and crew to the benefit of the service.

Having considered the generalities of officers' organization on board ship, we must now turn to particulars. The captain must naturally remain, as he always has been, responsible for all, and the soul of the ship in time of action. The executive officer should be responsible to the captain for all; his special charge should be the

care of the ship, of all stores for the ship's use, and of the discipline and organization of the crew. His station in action should not be in the fighting tower with the captain, as there would be a great probability of losing both together. If there should be a second fighting tower, the executive officer might occupy that; otherwise, he should be at liberty to go where his services may be required. He should command all expeditions out of the ship.

The navigator should have charge of all navigating, meteorological and surveying instruments and all charts, and should perform those duties of the paymaster which are not assumed by the divisional officers, as well as all navigating and hydrographic duties. In action he should be the captain's aide, navigating the ship when on soundings and attending to signals. He should have charge of all stores for the use of the crew, and should act as (army) quartermaster in all expeditions out of the ship. As his duties would not keep him in touch with the crew, some of the divisional officers should be his seniors, to prevent his replacing the executive officer. The present navigator's division should have a watch officer in command, who should have charge of the machine guns of the upper deck, and the fire from the tops. He should also look out for the torpedo netting and handle the electric lights in action. It is doubtful if one man could efficiently control the entire machine-gun battery even in small ships, but in large vessels it would certainly be necessary to make two divisions of it. The duties of the officers of the gun and powder divisions should not differ materially from the present practice. There should be a torpedo officer in charge of all the torpedoes and mines of the ship. He should command the torpedo division, and his station in action should be with the bow torpedoes. The junior officer of the torpedo division should command the torpedo boat of the ship. The torpedo officer should lay and fire all mines and countermines, and should be in charge of electrical machinery and gear. He should not belong to the landing party. One of the divisional officers should be the gunnery officer charged with the care and maintenance of all arms and ammunition, and he should not be in the landing party. Finally, the engines should be in charge of one or two officers responsible for the efficiency of the engines and that of the engine-room force, but not standing engine-room watch, nor undertaking the immediate supervision of work; these duties should be left to petty officers. Officers should be induced to qualify for the various special duties just enumerated by the offer of a permanent

supplement for the mere fact of qualification in any branch. An additional supplement should be granted during the actual performance of the special duty. Officers should stand watch at sea as they now do, but in port the charge of work should be committed as far as possible to petty officers. The divisional officers should stand day's duty, being responsible for work going on, but with time to attend to their special duties.

Organization of Enlisted Men on Shipboard.

The organization of the crews of our men-of-war should begin on shore in the navy yards, which, besides being supply and repairing depots, should be training stations for the men. There should be ample drill grounds and barracks, and here the boys from the training squadron, and the men returning from three months' leave after a cruise, should be sent to await orders to seagoing ships. It is a great mistake to keep receiving-ships. It is impossible to form seamen by merely teaching men to sleep in hammocks, and every other imaginable advantage is on the side of the barracks. The men should be organized on somewhat the same system as that at Annapolis, which affords the most favorable opportunities for division into classes, for instruction, drill and discipline, and renders it comparatively easy to deal even with recruits. There should be a large number of officers at the barracks in charge of the men, and there should be an effort to arrange details so as to send one or more officers from the barracks to the same ship with every detail of men, in order to maintain as far as possible the same method of drill both ashore and afloat.

In considering the position of petty officers, every one agrees that the old class of men is insufficient, and that to obtain desirable men more pay and more privileges must be offered. But pay, privileges, and comforts do not appeal with enough force to the intelligent and self-respecting class that is necessary, and the great inducements of increased trust and responsibility must be added. In fact, it is not too much to say that there is now no class of petty officers in the Navy, and that there can be no good organization without such a class. Those holding the ratings are simply leading seamen, drawing higher pay, but without the superior instruction, the security of tenure, the authority, and the respect for their own positions, which are necessary in every well-organized military body. Improvement

in petty officers can only be effected by marking them off as distinct from and superior to their shipmates, as is done with non-commissioned officers in the Marine Corps. The lines necessary to effect this can best be established in barracks, where the men who have served as petty officers should be rated as such and opportunities should be afforded for others to qualify; those under probation being rated as vacancies occur. The petty officers should be given a separate mess and quarters, as many privileges as possible, and should receive special instruction in their various duties. The charge of discipline and police duties and the instruction and drill of the force in barracks should be committed, as far as possible, to petty officers, and although they should be watched by the staff of officers, and instructed and counseled in the way of exercising command, yet they should always be made to feel that they are trusted and responsible for the performance of all work assigned to them. It is scarcely necessary to say that it is impossible to commit all drill and instruction to the petty officers, and that the officers must always make their control and initiative felt, and take direct charge of all bodies of men larger than a small squad. There is at present a class of petty officers—of whom quarter gunners are an example—who perform duties which require intelligence and reliability, but who exercise no military command; such men deserve high pay, but they should not form part of the body of petty officers described above. It is in this way, and with the advantages of a long term of enlistment, that marine officers have succeeded in forming a corps of men which is superior to that of the blue-jackets, and a class of non-commissioned officers who retain their authority and the respect of their subordinates throughout the trying circumstances of a long cruise.

On transferring a body of men to a ship about to be commissioned, it is necessary to organize them according to the bills. There are two classes of station bills: to one belong all the fighting bills, to the other belong all for handling the ship and carrying out routine work. The principle that should govern all the fighting bills is that, no matter how or when the men are brought into action, they should always find themselves under the same officers and petty officers. The working bills should be regarded merely as permanent details from the fighting bills, in order to distribute the work equally among all, and to prevent loss in battle from disturbing the routine of work. To accomplish this, the basis of all organization should be the quarter bill. The records and various qualifications of the men should be carefully

examined, after which they should be fairly distributed among the divisions, assigning a good marksman qualified in the gunnery branch to every gun. The qualified torpedo men should go to the torpedo room and the torpedo boats, the qualified mechanics and firemen to the engine room, and marksmen to the tops and other small-arms stations. The rest of the crew, of various degrees of training, should be assigned as necessity requires. The powder division will require great attention to ensure the prompt supply of small-arm ammunition to the tops and the sure delivery of the various calibres of machine-gun ammunition. Indeed, it is very probable that constructive changes in the vessels may be found necessary in order to obviate delay and mistakes. Every man should be assigned to the station which he is most capable of filling, and no changes should be made without a real necessity. It is quite wrong to shift men about merely to preserve an ideal symmetry in the station bills. The efforts of the captain and executive officer should be to encourage divisional *esprit de corps* and cause each officer and his division to feel that they belong to each other and must work together.

As it is proper for the crew to go to quarters upon any emergency, it is evident that the fire bill must be based upon the quarter bill, as it now is.

The next bill to make out should be the watch bill. It should have much the same relation to the quarter bill that it now has, so that losses in one division may be distributed to all parts of the ship; but both watches should be drawn equally from every gun's crew, as is now the case with pivot guns. The ease of handling the new guns will permit this without causing delay in opening fire.

The next bill made out should be the battalion bill. The force of the landing party for each class of ships should be prescribed in the Ordnance Manual, also the mode of armament and equipment and the numbers of pioneers and other auxiliaries. In uniting the forces of several ships, it would usually be advisable to change the equipments of some of the auxiliaries, or the kind of guns, or even to leave part of the artillery behind. Therefore, the proper proportion of guns and auxiliaries for each increase in the total force of an expedition should also be laid down in the Manual, and under each total the proper equipment for the first, second, and third ships participating. Each ship, having received a squadron number, would then know what force to send.

In organizing the battalion, each division should furnish a complete

company under an officer of that division. If it should sometimes be necessary to form a company with men of two divisions in order to have it of full size, the two divisions should be represented by the platoons, each with its own officer. With modern guns, the guns' crews are usually large enough to work with half crews, and therefore the second half of all guns' crews should furnish the infantry. Care should be taken to have the best small-arms marksmen and most active men in the landing party. The riflemen belonging to the tops should be men not so good at marching, and should be left on board for the protection of the ship. Some of the machine guns, each with its complete crew, and details from the rest of the machine-gun division, should form the artillery. The pioneers and mechanics should come from the engineer's division, and the special details for the care of stores, for stretchermen and other duties, should come from the powder division. This division might be able to furnish a company of infantry, but if possible it should keep nearly its full strength on board, in order to enable the half crews remaining on board to maintain a brisk fire, in case of an attack during the absence of the battalion.

The boat bills come next. There should be two of them. The first one should be similar to the battalion bill, so that on arming, each company or platoon would remain a unit and form the crew of a boat. Coxswains should all belong to the battalion and to their own boats. The second boat bill should be the "abandon-ship" bill, and should contain the names of all on board; each boat containing its fair proportion of mechanics, seamen, idlers, etc. Some of these men would be permanently excused from boat duty; the rest should form the boat's crew, the coxswain detailing the crew for each day precisely as the captain of a part of the ship now makes his details. There should be no boat officers: coxswains should be held responsible for the conduct of their crews.

In the organization of the engine-room and fire-room force, those men should be assigned there who are in receipt of the supplements for duty in that division. This should not prevent them from obtaining some of the lower supplements for gunnery and target practice; and, *vice versa*, the men of the deck divisions would be better for some elementary knowledge of steam. We may see this exemplified every day in the steam launches when the coxswain starts the engines or the fireman finds it convenient to bring the boat to the gangway; and, with the isolation attendant on the modern sub-

division of ships, the diffusion of such knowledge becomes essential. It also seems as if the present multiplicity of independent engines on shipboard, far from rendering necessary the employment of highly educated scientific engineers to take charge of them, affords precisely the opportunity for such an organization as has been indicated, where the engine-room watch is committed to well-trained petty officers.

The mess bill must always depend on the watch bill; but as long as the present system of messing is retained, it should also depend on the battalion bill, so as to send ashore complete messes without disorganizing those that remain. This could be accomplished by making the second parts of the guns' crews of any one division (which form a company) belong to the same watch, and mess together. It would be equally easy to place the field artillery in one mess. The present system of messing should no longer be retained, for it is little better than barbarous, and of itself is sufficient to forbid the enlistment of a desirable class of men; especially when the training ships are so much better in this respect. It is wasteful of provisions, unfavorable to good cooking, and keeps an encumbered and close-smelling berth deck, besides requiring a large number of mess cooks, who are usually dirty foreigners wanting the extra ration, whom the executive is ashamed to have about the decks, whose time is not half occupied, yet who avail themselves of their mess duties to avoid their deck work. There should be a ship's pantry on every ship, and the ship's cook should have a small number of assistants—enough to do all the cooking and take entire charge of the pantry, with its mess gear, and do all the washing of dishes, etc. The berth-deck sweepers should set the tables and draw and return the mess gear. Some of the cooks should be attached to the landing force, and on landing every man should carry his own mess gear, as at present. The petty officers' mess should be rather better than the others, with china service, and permission to use mess money. The other messes should all be on the same footing, without mess money. The savings in the ration, owing to the decrease of waste, would be very considerable, and the commutation, with the improvement in cooking, would furnish a very good table.

There should be a meal between 7 and 8 P. M., for it seems to be shown that the desire for liquor when on liberty is decreased when the length of the fast between supper and breakfast is habitually shortened.

DISCIPLINE.

Discipline, which secures efficiency through obedience, is the strength of every military organization, and is established by the wise bestowal of privileges and rewards, by the infliction of punishments, and by drill, which forms the habit of obedience. But whereas the enforced obedience of the ignorant men of former times produced sufficient results, the recent improvements in all military branches demand a degree of intelligence and alacrity in the performance of duty which must be induced rather than enforced, and this must bring changes in the mode of discipline, some of which have already been indicated in speaking of a mode of payment depending on a system of rewards for proficiency.

There are now two principal privileges—monthly money and liberty. The reservation of pay has been already alluded to as a cause of preventing enlistments, but it is also injurious to discipline; for it lowers a man's self-respect when he is not trusted with his own, and there can be no greater absurdity and injustice than in paying as a privilege the wages which have already been earned. The entire monthly wages should therefore be paid every month as a right. Liberty depends altogether upon conduct, and in this particular, as in many others in the service, there is no recognized custom, every commanding officer following his own ideas on the subject. Drunkenness, the most common offense in the Navy, is closely connected with liberty; and with regard to its punishment, great latitude is allowed to captains. This diversity of treatment is injurious to discipline, and is a frequent cause of desertion, as it is very easy to ship on another vessel without identification. There should be a set of rules governing the privilege of liberty and the punishment of drunkenness, which should be closely adhered to by all the vessels of the Navy. Liberty should be granted to first-class-conduct men whenever their services are not required on board; and frequently to all.

Minor punishments are in the hands of the captain, but for all except the smallest offenses he must convene a summary court-martial. Any three commissioned officers on board the ship may compose one of these courts, which take cognizance of the class of offenses which come before police magistrates and award penalties of about the same degree.

The law seems to say that any three men bearing commissions, no matter how recent the commissions, nor how ignorant of naval law,

customs, and necessities the men may be, can execute naval justice better than a captain who has spent his life in the service and is thought fit to be trusted with the honor of the flag, the lives of his crew, and the safety of his ship. But there are many objections to summary courts. There is frequently a member anxious to display his knowledge of law even at the expense of justice: then, when a finding has been made, it is difficult to decide on a sentence, so that if several cases for the same offense come before the same court, there are frequently several different punishments awarded, each representing a compromise, or the views of an individual member of the court. Even when the court has finished its work, the revising officer may wish to show himself a lawyer and quash a well-deserved sentence on some trifling technicality. In a word, the formalities incident to summary courts hinder substantial justice, and powers vested in them should be committed to commanding officers; for if a man is fit to be trusted with command, he is surely fit to enforce the discipline by which he vindicates his trust. General courts-martial are open to the same objections as summary courts, but their duties and powers are too great to be all entrusted to one man. They should never consist of more than five or seven members, in order to increase the sense of individual responsibility and the dispatch of business, and to decrease their cost. The functions of general courts should cease after making the finding, thus assimilating their duties to those of civil juries. The commander-in-chief should have authority to send the proceedings back for revision, and to award sentences equal to those now awarded by summary courts, or else, in more serious cases, to send the offenders to the United States for sentence by the Secretary of the Navy through the Judge Advocate-General. In this way adequate punishments would be more frequently awarded, and the discipline of the Navy would be more completely under the control of the Secretary, who is responsible for the Navy in all its branches.

There are many occasions upon which subordinate officers find it necessary to take notice of trifling offenses scarcely worthy of reporting to the commanding officer. Under these circumstances it is easy to find some way of evading the regulations, punishing the man without avowing it, and this is generally done. Such proceedings cannot be favorable to discipline, for one always feels a sense of injustice at illegal punishment, no matter how well deserved. To provide for such cases, divisional officers should be permitted to

inflict certain small punishments in the way of extra duties and the like, which should be entered in a book for the captain's inspection as a check against abuse; but they should be in nowise prejudicial to the record or privileges of delinquents.

There should be a code of punishments carefully drawn up, after the manner of the civil code, prescribing a maximum and minimum punishment for each class of offense. This would do much toward obtaining uniformity of punishment, especially in the minor cases dealt with by commanding officers.

Finally, in the instruction of recruits, officers should pay great attention to the explanation of the principles of military honor and devotion to duty, and thereafter no opportunity should ever be lost of inculcating them both by example and instruction, and by the mode of punishment selected for individual offenses. Our men are intelligent enough to respond to such ideas, which are more conducive to good discipline than anything else.

DRILL.

The drill of the Navy is at present unsatisfactory, for it does not realize the full measure of efficiency of which even our poor ships are capable. Drills are in charge of the various bureaus of the Navy Department, but there is no system about them, for one bureau may draw up instructions and manuals, while the returns from the ships are made to another; and, as was said before in this essay, a commanding officer hears quickly of an informality in his quarterly drill returns, although their substance seems to be a matter of indifference, and the Department's solicitude for a ship's efficiency apparently ends when she is commissioned.

On board ship we find the drills prescribed in the Ordnance Manual carried out in a perfunctory way, but the instruction given is inferior to the capabilities of the arms, and target practice amounts to nothing. With regard to all other drills there is absolutely no uniformity. Every squadron changes its sail and spar drills with a change of admirals, and the new flag lieutenant edits a new edition of the little book on routine, seamanship drills, and the signal book. Except by the marines, Upton's Infantry Tactics is scarcely more regarded than Luce's Seamanship; both are acknowledged to be very good authority on their respective subjects. In all drills, officers have no hesitation in departing from the usual or authorized

custom, if they think they can improve thereon. This should not be permitted, but manuals for all drills should be published by the Department and enforced by the inspectors, upon whom the efficiency of the Navy would greatly depend.

The objects of drill may be laid down as follows: To maintain discipline and *esprit de corps;* to instruct in the use of all weapons and in the management of the ship; to maintain a high standard of physical endurance, and to afford occupation and employment.

In former times discipline was simply the habit of obedience, formed by the constant repetition of manœuvres at drill, and enforced by brutal punishments; but general education and the habits of freedom have advanced so far in this country, and the intelligence demanded for the proper use of modern weapons is so great, that the old methods of drill and discipline are no longer suitable: henceforward we must reach efficiency not by attempting to form a habit of blind obedience, but by developing individual intelligence, self-reliance and resource, and by raising the self-respect of every man in the Navy, so that each one may feel that in an emergency he may depend upon his comrades as upon himself. At present, drill should partake very much of the nature of instruction, and the principles underlying every order and manœuvre should be carefully and thoroughly explained: duty will be much better executed in consequence. At the same time, this explanation of orders on the drill-ground or in the class-room must never be allowed to conflict with the disciplinary principle of unquestioning and unhesitating obedience.

The second object of drill—instruction in the use of weapons—is of an importance which need not be enlarged upon, yet it is precisely the one in which our Navy is most deficient. The men understand their rifles so little that a great many are rendered useless by careless handling, and they have no idea about shooting. The allowance for small-arm target practice is two shots a month, but even this is not always expended. Besides, the target is usually swung from the yardarm or towed astern, where it is impossible to verify hits. In the Army, twenty cartridges a month are allowed, with materials for reloading, so that in some companies every man expends as much as fifty or sixty shots a month at target practice, and there have been companies in which every man had the score of "marksman." The allowance for great-gun target practice is two shots a month a gun's crew. This allowance is nearer what it should be than that for small-arms, but the results in time of war of any expenditure in this direction are so great that the allowance should be increased.

The handling of the ship comprises two branches: naval tactics and seamanship. Naval tactics is a drill by which only officers profit, and absolutely nothing of it is known in our Navy; but seamanship belongs quite as much to enlisted men as it does to officers. It is claimed, indeed, that the latter is a thing of the past, belonging to the sailing fleets; and there are those who say that the resource and ingenuity which were eminently characteristic of the seamen of former times no longer exist, or belong only to those who have been brought up in sailing ships. There can be no doubt that the reason thus urged for maintaining a sailing training squadron is quite sound; but as the fleets of the future will be of steamers, the use of a sailing squadron will be like an education in a dead language. A modern squadron, properly exercised, cultivates so many accomplishments in its crews, that we may safely believe the seamen of the future will be as prompt in emergencies and as fertile in resources as their predecessors. Still, as our fleet yet depends in a great degree on sails, and there is no squadron of evolutions, it is quite too early to think of the abolition of the sailing training squadron. A most important object of drill is the maintenance of physical training. It is specially important for officers, because the men are in fair condition from their daily work; but the habits of officers are so sedentary, it is not too much to say that their physical training is not enough to fit them to lead their men in war. Any drill whose object is simply to afford occupation, as is sometimes desirable, should be such as to develop this important end.

Drills may be classified into personal instruction, divisional exercise, ship drill and squadron drill. Upon the thoroughness of the personal instruction given to recruits will depend all success in war. The recent developments of naval and military warfare follow very different lines, yet they have the common result of increasing very greatly the importance of the individual, which necessitates a correspondingly increased proportion of personal instruction in all drill. In the Navy this importance of the individual arises from the accuracy of weapons; from the decrease in the numbers of great-guns, rendering it impossible to depend for results upon an average of shooting where every shot ought to tell; and from the modern subdivision of ships, which requires every man to be self-dependent in order to meet the emergencies which may arise near him. Personal instruction is altogether out of place on board a man-of-war, where the entire organization is for service and not for a school. Cruising vessels, therefore, should never be permitted to recruit.

The barrack system, which was mentioned as favorable to discipline, is equally favorable to drill and to health, and should be adopted for the training school for boys. The general system of such a school should be similar in principle to that adopted at the Naval Academy, differing only in giving the boys a shorter course and a larger proportion of practical instruction and drill. The staff of this school should consist largely of petty officers, who should give instruction in practical work and should have a large degree of authority, thus teaching the boys from the first to respect and look up to them. The course should comprise the completion of a common-school education and practical instruction in gunnery, small-arms, seamanship, steam and signals. The theoretical instruction should be merely such as to enable the boys to understand the principles of their drill.

There should also be great attention paid to fencing and boxing, and every means should be taken to encourage these accomplishments as recreations. It is scarcely possible that we shall ever recur to boarding, but one of the Chinese vessels at Foo-Chow was so captured, and perhaps it may be useful in some exceptional case. In the meantime, broadsword exercise and boxing are manly accomplishments well adapted to shipboard, and developing judgment, temper, self-reliance and physique—precisely the qualities that are needed in a seaman. Every man-of-war should therefore be abundantly supplied with masks, single-sticks, and gloves, and officers should be obliged to exercise with them as well as the men, for they need it more to keep in training, and should always exceed their men in their knowledge of weapons and drill.

But instruction should chiefly be directed towards the management of weapons and machinery. The mechanism and nomenclature of all guns and small-arms should be fully explained; the precautions to be observed with ammunition and torpedoes should be taught, and the methods of connecting electrical wires, the use of switches, and other simple electrical information. With regard to the engines, every one should be taught how to start and stop a boat engine, and something about looking out for the boilers. It should never be forgotten that a good man-of-war's-man, besides knowing his own business well, should know something of everybody else's business.

The greatest pains should be taken with target practice, for good shooting is of vital importance, and the confidence begotten of skill reacts upon the shooting. It is impossible to develop the full capabilities of small-arms with the opportunities afforded for target practice

on shipboard, and therefore the importance of thorough instruction on shore is redoubled. Target practice should include the estimation of distances, the allowances for wind and speed, and shooting at every variety of target, such as at moving targets of various colors and with different backgrounds, at disappearing targets at different ranges, etc. Great-gun target practice need not be given at this elementary school, for it is too expensive for all to receive a thorough instruction. A course in it should be reserved for the best marksmen, and they should be instructed in the same thorough manner as in small-arm practice. A thorough basis of practical information having thus been laid, the divisional exercise should follow, to teach the recruits to work in unison and mutually support each other. They should be taught to handle the great-guns, to drill in the company and battalion, and special efforts should be directed towards securing the control of firing by means of sham fights. There should be much exercise in boats and steam launches, with practice in laying mines and searching for the enemy's mines, and in the use of the electric search-light in sweeping the horizon and estimating distances of torpedo boats and other objects, and in the duties of picket boats. With all this, the instruction in the routine duties of seamanship and the daily work of the ship should not be neglected; but it is unnecessary to enlarge upon these.

Recruits, having thus gone through the course at the training school, would be ready for seagoing ships, and should be transferred to the barracks at the navy yards to wait for a ship. Here they should perform such work in the rigging lofts and in fitting out ships as may be necessary, and should continue their drills.

On joining a ship the recruits would find themselves with a substantial basis of knowledge regarding their duties, and their services would be valuable from the first. They would have opportunities of selecting a specialty, and after three months' leave at the expiration of their cruise, they should return to the training school, there to follow an advanced course in one of the professional branches of steam, gunnery and great-gun target practice, or signals and navigating work; and on the degree of proficiency obtained in these courses should depend the amount of the supplements to the pay.

On board ship no drill should be permitted which does not directly contribute either to the safety and proper management of the ship or to her efficiency in battle. Target practice, signals, and fencing should be continually practised for the sake of maintaining individual effi-

ciency and physical training, and the divisional exercises would teach the men mutually to support and aid each other. These exercises should always be smartly carried out, and stupid men should never be permitted to interrupt their course, but should be turned over to a petty officer for instruction. It should be the effort of every individual officer to ascertain and develop the full capabilities of his division, and to ensure to himself a proper degree of control of the firing, if in the gun or torpedo divisions. When the officers and crew have become acquainted with the ship and with each other, the captain should proceed to exercise at ship drills. These include clearing for action, general and fire quarters, battalion, boat and seamanship drills. For the enlisted men these drills are little more than repetitions of the divisional exercises, but they are of great importance to officers, and the captain and executive officer should take great care in instructing them and in causing them to bring out the maximum efficiency of their commands. Seamanship drill is diminishing yearly in importance as the use of steam increases and spars become lighter and fewer; but it remains a favorite drill, as it affords an opportunity for active exercise and rivalry between ships. As, however, it no longer contributes to fighting efficiency, its prominence as an exercise drill should be taken by "Clear ship for action." Here we would have a display of seamanship in preparing the military masts and in hoisting out the torpedo boats; and below, the watertight doors and armored hatches call for good organization to secure their efficiency. But the principal work would be with the torpedo netting. This has been proved indispensable for the protection of every ship at anchor, and to get it up, prepare it and rig it out quickly would be an excellent test of seamanship and efficiency. With regard to general quarters, it should be the captain's first effort to ascertain by experiment, and then to maintain by practice, the best means of establishing his control over the divisional officers, and of ensuring to himself the prompt receipt of intelligence from all parts of the ship. Beyond this, general quarters amounts to very little, except when manœuvring in sham fight with other vessels.

Night general quarters should take the form of an attack with torpedo boats, sending out the ship's torpedo boats to attempt a surprise, and at their discovery the ship should clear for action and go to general quarters. The use of the electric search-light and the way to profit by it should be studied by every one.

As for fire quarters, it does not seem as if fire could prove a very

threatening thing in iron ships minutely subdivided and with fixed hose-pipes. At all events, it should be dealt with by the people in the compartment with it, and the principal effort at drill should be directed towards securing prompt communication with the pumps, in order to have the water turned on.

Boat drill under oars and sail, and under arms with artillery, musketry and search-lights, with boat-squadron manœuvres, forms an important part of the battalion drill. The landing of the French at Sfax is an example of perfection in this particular and of the advantages to be derived from it. Battalion drill should be carried out with great thoroughness and with perfect uniformity throughout the service. The evolutions taught should be few, comprehending only those practical ones of service in war; but the duties of sentries, patrols and pickets, and of encamping, as well as the mode of landing and embarking, should be much dwelt upon, and every opportunity should be taken of practising them.

But there is another class of ship drills of benefit to officers only, and this is the manœuvring of the ship. Upon joining a ship, it should be one of the first duties of every officer to make himself acquainted with the particulars of her construction, armament and equipment, and with her nautical, tactical and combatant qualities and peculiarities. She should be constantly manœuvred until all the officers are thoroughly acquainted with the particular action of the screws upon the helm in backing, and until the tactical diameter is known and every one has some proficiency in estimating by the eye the curved course she will describe in trying to ram a passing adversary. To this end there should be much practice in trying to ram moving targets. This exercise is one to which special attention should be given at night, for then the value of the ram is at its maximum. Next, the ship should practise manœuvring in company with her torpedo boats, which should learn to cover themselves behind the ship, and how to keep clear of the ship's torpedoes while securing the efficiency of their own.

We now come to squadron drill. An evolutionary squadron is an absolute necessity for the proper drill and instruction of officers and men, and upon the thoroughness and completeness of the methods of the evolutionary squadron will depend all success in war. The squadron is further necessary as the only means for ascertaining the efficiency of the general system selected for the Navy, and the directions in which improvements are called for in construction, drill or

tactics. As examples of this latter use of the evolutionary squadron, the recent manœuvres of the Germans have convinced them of the complete reliability of their present system of coast defense by means of mines and torpedo boats supported by coast fortifications and a fleet. The English manœuvres of last summer taught them the value of the Polyphemus and Hecla types of vessels, and the necessity of altering the type of torpedo boat. Torpedo nettings also proved a complete success, and are henceforward indispensable. The Italian manœuvres of 1885 teach the tactical lesson that a fleet can derive no support from an unfortified harbor, no matter what its natural advantages.

For a squadron of evolutions, the North Atlantic is the most suitable, as it is the "home squadron." On all questions of custom, etiquette and drill not decided by the Regulations or Instructions, the usage of the evolutionary squadron should govern all others. All newly commissioned ships should join this squadron before going abroad, in order to drill and acquire the uniformity of style which is one of the most prominent evidences of discipline and efficiency. In this squadron is afforded the opportunity for the acquirement of nerve and skill in handling vessels, for learning the means of utilizing their armament and qualities to the best advantage and of defending them against attack and surprise.

In short, we make progress in naval science by approaching as closely as possible the conditions of actual warfare. On assembling the fleet, the admiral's first efforts should be directed towards establishing his control over it, through the adoption of a proper organization and grouping and the perfection of the methods of signaling. The imperfect method of the latter seems to offer one of the most formidable obstacles to the prompt and united action of the fleet. Squadron tactics and manœuvres should follow, in order to teach officers to maintain position and give them steadiness and skill in handling the vessels. In carrying out these manœuvres, the opportunity should be taken to develop scouting duties both by large ships and torpedo boats. These vessels should reconnoitre the coasts, examine harbors, and follow suspicious vessels. The electric light should be freely used as an offensive weapon to search the horizon and coasts. Attention should be paid to the estimation of distances both of vessels and landmarks by day and night. Then should come the combats of ship against ship, when the captains should direct their attention towards the peculiarities of their ships, and the best

mode of attack and retreat as developed against the various types of their adversaries. In these sham fights powder should be freely used, in order to examine the effects of the smoke and its influence on tactics, for this seems to be a most embarrassing accompaniment of battle. Then should come exercises of one ship against two, to show the pair the best way of supporting each other while the efforts of the single ship would be to separate them. Then the same set of manœuvres should be executed with the vessels supported by their respective torpedo boats. In port the squadron should exercise at establishing its defenses with nettings, booms, lines of torpedo mines and picket boats. The large vessels on scouting duty should learn to hide themselves under the shadow of the coasts, and not to betray themselves by too high a speed. In the recent English manœuvres the enemy was frequently discovered by the line of foam at the bows. The use of the electric light as a defensive weapon should also be studied, and the best way of illuminating the entire horizon when all the lights of the squadron are available. The duties of the torpedo boats as pickets and in reconnaissances are important, and they should also be employed in night attacks. The squadron should land the battalions with complete stores for taking the field, and the vessels should practise covering the landing with the guns, and with torpedo boats armed with machine guns. After landing, the battalion should divide into two parts and exercise in sham fights, and in embarking in the face of the enemy, and in all the duties of picketing and reconnoitring work. The attack of fortifications should be practised, by which the Army would profit as much as the Navy. This would exercise the squadron in indicating an unbuoyed channel, in removing obstructions by dragging and countermining, and would show the possibilities of forcing a passage through obstructions. The fleet should also divide into two parts, one acting as a support to the fortifications, and in this way most valuable aid could be given to the Army in regard to the fortifications at each port, and the fleet could learn the peculiarities of the principal ports. The torpedo flotilla should manœuvre in tactics, as a school for the younger officers; and as flotilla against flotilla there would be developed the peculiar tactics suitable for these small craft in attacking each other. They should learn how to avoid the torpedo chasers, and, as far as possible, should exercise all along the coast, in order that officers may be thoroughly acquainted with the intricacies of the entire coast. Finally, the divided fleet should manœuvre as opposing squadrons on the high

seas, using the support of torpedo boats, and approaching as nearly as possible the conditions of actual battle; and exercises should frequently take place at night. In all these sham battles every possible stratagem and deception should be used against the enemy, in order to teach constant vigilance and suspicion. A Chilian vessel was blown up in Callao by a seeming fruit boat, and last autumn one of the Italian squadron of evolutions was put out of action by a similar stratagem.

In conclusion, the points of this essay may be summed up as follows:

1st. As a ship, though composed of many parts, is yet one fighting machine, she should be entirely manned by one corps of officers and one corps of enlisted men, whose members should be acquainted with all duties on shipboard in a greater or less degree. But, in recognition of the great field thus opened, each should devote himself more particularly to the study of some specialty when on shore duty, and its practice when at sea. The lines between the specialities would be more deeply marked in the corps of enlisted men, because they would not rise to command, which of itself is a specialty embracing all others.

2d. As far as possible, good conduct, proficiency, and zeal should be obtained by offering a direct pecuniary reward to officers and men, and quicker promotion to able officers.

3d. Officers should be obliged to increase their professional knowledge by following special courses at a post-graduate school.

4th. A body of trustworthy, intelligent and responsible petty officers holding their positions securely is an absolute necessity.

5th. Discipline should be maintained by raising the self-respect and devotion of the men. They should be habitually granted every possible privilege and comfort, and punishments should be entrusted to responsible individuals rather than to courts.

6th. All drills should contribute directly to efficiency in war, either by improving knowledge and proficiency, or by developing physical training both of officers and men. All drill should be directed towards the development of individual intelligence, resource and self-reliance, rather than towards forming an instinctive adherence to routine.

It may be mentioned that there is no feature of this essay which does not find its counterpart or analogy in some other service.

UNITED STATES NAVAL INSTITUTE, ANNAPOLIS, MD.

JUNE 7, 1886.

Commander P. F. HARRINGTON, U. S. N., in the Chair.

CORROSION OF THE COPPER OF THE JUNIATA.

BY CHARLES E. MUNROE.

On October 23, 1882, I received telegraphic orders from the Secretary of the Navy to proceed to New York and examine the Juniata, with the object of ascertaining the cause of the corrosion of her copper. On reporting there I found the Juniata in dry dock, and an examination of her copper showed that the immersed surface had become covered with a pale green, earthy-looking coating, which at the time had become dry in spots and blistered. Many of these blisters had split, and the coating had flaked off to such an extent that the floor of the dock was thickly strewn with them. While the outer surfaces of these scales were of an apple-green color, the inner was, in the main, of a copper-red color, though in some instances it was black. The surface of the copper where thus exposed was, in the main, of a copper-red color, but in some spots black. Where these black spots appeared they were imperfectly circular in shape.

In addition to this general action which had caused the incrustation over the entire wetted surface, it was found that several plates had been so corroded as to be nearly or completely perforated. Eleven sheets on the keel, and sixteen on the bottom, most of them below the turn of the bilge, were so badly corroded as to require removal, and there were many others which gave promise of being soon in the same condition. This corrosion did not involve the whole of the plate on which it existed, nor was every plate attacked, nor in most cases contiguous plates, nor did it, in any case observed, extend to the nails or about them. The action was so irregularly distributed about the bottom and on the surface of the plates attacked, that there

could be little doubt that the cause at work was a purely local one. When corrosion had gone on to the extent described, the outline of the spot was irregularly circular in shape, and the areas decreased unevenly from the outer surface inward, giving to the perforation an irregular cone-shape of very wide angle, the sides of the cone being in steps. The copper at these points seemed to be laminated.

Further inspection showed that a portion of the copper on the keel, and all of the copper on the rudder, was covered with a greenish incrustation which was harder, firmer, and more coherent than that on the remainder of the ship, and that this copper was *wholly* free from any evidences of corrosion. The portion on the keel was midway fore and aft at the top of the keel. It was a goring-shaped section, and, roughly estimated, it was fifty feet in length, and tapered from eighteen inches wide midway to a point at either end. Although this strip was wholly free from local corrosion, yet sheets of copper below it, on the keel, and above it, on the hull, were corroded as described. So on the stern there were several corroded sheets, while the copper on the rudder, immediately adjacent, was free from all evidences of it. From their location it was evident that this copper on the rudder and the top of the keel had been subjected to the same conditions of exposure after immersion as the remainder of the copper on the immersed surface.

The history of the Juniata was officially given as follows: When she had received her suit of copper, she was removed from the dry dock and lay in the Wallabout, under the iron derrick, for about five months; she was then moved to the wharf at the foot of Main street, near Store No. 30, where she lay for one and a half months. From there she was moved to the ordnance dock, where she remained three days; again moved to the foot of Main street, where she lay for a day and a half, and then was taken into the dry dock again. This was two days before I reported in New York. The corrosion noted had consequently taken place during the six to seven months in which the vessel was lying in the Wallabout. The copper on the rudder and the goring-shaped section on the keel were said to have been a portion of the old suit of copper which had been put on at the League Island Yard many years before. The goring-shaped piece owed its form to the fact that the ship was "hogged," and when pieces were inserted to straighten up the keel, it was thought unnecessary to strip the old copper from the old keel.

My attention was next turned to the examination of the new, unused

copper from which the copper for the Juniata had been taken. I first, while examining the bottom, inquired of the workmen if they had noticed any peculiarity in the appearance of the copper as they put it on, and I found that they had remarked upon the "picturing," as they termed it, which seemed to be unusual. I applied then for sheets of copper from the same batch, and found that a few remained in the storehouse. On inspection I found that this "picturing" of which the workmen spoke was in the form of irregularly circular black spots and streaks on the surface of the copper. My first impression was that these spots were probably due to the fact that during transportation moisture had gathered on the surface of the plates, and that this moisture had absorbed hydrogen or ammonium sulphide from the bilge gases of the ship in which they were transported, and that this had tarnished them; but on examining the spots by light reflected at a wide angle, and by the sense of touch, it seemed probable that the plates had been rolled since the spots were formed, since the lustre on the spots was quite as brilliant as elsewhere on the surface. This theory of staining was not credited in the Constructor's Department of the Yard, as it was generally understood that the sheets were in this condition when put aboard the transport boat.

I next directed my efforts to tracing up the history of the Juniata copper. I hoped to ascertain when it was received and where it was rolled; then from the marks upon the sheets to learn from what batch of copper it had come; then to follow up these cakes to the smelting works, and from this point determine the source and character of the ore from which it was made. With this knowledge of the source of the copper and the various processes through which it had passed, I hoped to discover the source of any physical or chemical imperfections which the sheets might contain; but at the outset I found that there were no marks upon these sheets of copper by which they could be identified, and that the different invoices received at the New York Yard were so mixed as to be indistinguishable. All that I could learn was that all of the sheathing used was rolled at the Washington Yard. Since such difficulties as have arisen in the case of the Juniata's copper are likely to recur, it will assist materially in discovering the source of the difficulty if the history of the copper is known. I would recommend that hereafter a full record of the copper should be kept, and that each sheet should be stamped in the upper left-hand corner with the number of the batch from which it comes. This mark will be preserved by the lap of the sheet above. That this is feasible is

shown by a sheet of the old copper, stripped some two years previously from the Brooklyn, after it had been some years in service, which bears distinctly the following mark in left-hand upper corner, "U. S. N. Y. W., 1866." Starting from this point it will then be possible to compile from the log-books of a ship such statistics regarding the time the copper has been in use, and the conditions to which it has been exposed, as will enable us to determine the average life of copper sheathing—an important fact about which there now seems to be considerable uncertainty.

I next examined the Wallabout, a crescent-shaped body of water, something over 400 feet wide, lying between the Navy Yard proper and the cob dock. With the flood tide the current passes through to the westward, and with the ebb tide it moves to the eastward. Emptying into it are three sewers. At the east end, opposite the ordnance dock, is the Williamsburgh sewer, which drains 2300 acres of improved property, a considerable part being covered by petroleum refineries, chemical works, sugar refineries, and the like. About 500 feet from the dry dock the Brooklyn sewer, which traverses the Navy Yard, empties into the Wallabout. This drains an area of about 550 acres of improved property largely covered by residences. Near Store No. 30 a small sewer empties which drains a portion of the Navy Yard; and near the west end of the Wallabout the Hudson-avenue sewer, which drains 472 acres of Brooklyn, empties. The result of all this sewage flowing into the Wallabout is to modify very considerably the character of the sea water. The first effect observed is that which always takes place where sewage, charged with dissolved and suspended matter, flows into salt water—viz.: the precipitation of the suspended and dissolved matter and the formation of mud banks. This is going on continually in the Wallabout, and one of the largest banks was formed under the iron derrick where the Juniata lay for about five months. So shoal was it that she rested in the mud at low water, and in fact was probably imbedded in it for the greater part of the time. From this bank I gathered specimens of the mud, and I also got specimens of the bottom from off the ordnance dock. The first was regular dock mud, but the second consisted largely of coal tar. This last was accounted for by the existence, about opposite, of two large gas works, the "People's" and the "Nassau," while at the west end of the Wallabout there is a third. From the Williamsburgh and the Brooklyn sewers samples of sewage were taken. The color and character of the

sewage as it flowed from the sewers showed that the first was from factories, while the second was largely from dwellings. All the samples of sewage and mud were tested immediately after gathering, and all were found to be slightly *acid*. Naturally the character of the sewage flowing in, and consequently of the water in the Wallabout, will vary with the season, the day, and the state of the tide, so that the examination of only one set of samples is not of any value, except as indicating the character of the water at the time they were gathered. Realizing this, I applied to the Health Department of the city of Brooklyn, and also to Professor Charles F. Chandler, President Board of Health of New York, for information concerning the sewage emptying into the East River, but no investigation of this sort seems to have been made. Professor Chandler says, however, "There are a great number of petroleum refineries on Long Island at Hunter's Point and at Newtown Creek, and these refineries use enormous quantities of sulphuric acid, some portions of which find their way into the river. There are also chemical factories in Brooklyn—quite a number of them—and possibly their refuse materials are discharged from the sewers, by which the water along that shore may be rendered quite different from ordinary sea water." Through the courtesy of Civil Engineer F. C. Prindle, U. S. N., and Mr. J. H. Raymond, Commissioner of Health of the city of Brooklyn, I have obtained much of the information concerning the sewers which is given above. It would seem likely that considerable ammonia would reach the Wallabout from the gas works, were it not that ammonia has become so valuable an article, and the processes for recovering it from gas works have become so improved as to prevent much of it being allowed to escape. It is probable, too, that the considerable deposit of coal tar discovered at the end of the ordnance dock accumulated before these by-products of gas-making had become of any commercial value.

Besides the specimens of mud and sewage, one sheet of new copper from the lot from which the Juniata's copper was probably taken, five corroded sheets stripped from the Juniata, a strip of the copper from the rudder of the Juniata, and a sheet of the old copper which had been stripped from the Brooklyn when she was last recoppered here, were taken for examination.

Before leaving the Navy Yard I examined the pile of old copper stripped from the Brooklyn when she was last repaired. Although this had been in service many years (just how long I could not ascer-

tain), much of it was so strong that it drew out the nails in coming off. Some of the sheets were eaten through in much the same way as was seen in the Juniata's copper, but there were very few of them. Naval Constructor W. L. Mintonye, U. S. N., informed me that sheets of this old copper had been used for covering the anchor hoy used in the Wallabout, that these sheets had been in use thus for about two years, and that during that time the anchor hoy frequently rested on the mud banks, yet the copper was sound. Mr. Mintonye also described some experiments which he had made with the Juniata's copper. He took sheets from the lot with which the Juniata was sheathed, and coupled them in pairs by blocks of wood. At the time the Juniata was coppered he buried one of these pairs in the mud; the second was suspended six feet from the surface of the water, and the third was suspended at the surface of the water at low-water mark. These couples remained until the Juniata was docked in October, 1882. They were then taken out, and all were found unchanged except the couple buried in the mud, and these were only tarnished.

During my inspection of the bottom of the Juniata, I was accompanied by Chief Constructor T. D. Wilson, U. S. N., and he suggested in explanation of the corrosion that it was due (1) to iron coming in contact with the copper, and that this probably occurred while the Juniata was lying in the mud bank under the iron derrick, as it was rumored that iron chains and other iron articles had been lost in this mud bank from time to time. Since my visit to the Navy Yard this mud bank has been removed by dredging, but I cannot learn that any such articles have been recovered.

Another theory (2) advanced to account for the corrosion is that it was due to the sewage which flows into the Wallabout in such quantity. This was evidently in mind when my orders were drawn, as they read: "Your attention is called to the fact that a large sewer discharges into the Wallabout at a point near the wharf to which the Juniata has recently been moved."

Another (3) is that it was due to impurities in the copper, arising either from imperfect refining, impure ores, or the intentional admixture of foreign and cheaper metals.

Another (4) is that it was due to iron removed by abrasion, or in the form of rust, from the rolls in the rolling mill.

Another (5) is that it was caused by the adhesion of coal tar.

Another (6) is that it was due to physical or chemical differences

in different parts of the copper, which were caused by the method of manufacture.

On the 6th of December, 1882, in obedience to orders I proceeded to Washington, and there examined the sheets of corroded copper from the U. S. S. Brooklyn which were sent from Rio Janeiro. The corroded sheets presented practically the same appearance as those from the Juniata. There was the same irregularly circular outline, and the corrosion was seen in all stages, from a roughened surface at the outer edge of the circle to a thin edge at the centre. Through the courtesy of the Chief of the Bureau of Construction, I examined the report of the condition of the Brooklyn, with the accompanying drawings. These sketches showed that there was no regularity in the distribution of the corrosion, though most of the corroded sheets were below the turn of the bilge.

On the 9th of December, in obedience to orders, I proceeded to New York to examine the U. S. S. Trenton, then in dry dock. On inspection I found her copper to be in a very sound condition, so far as local corrosion was concerned, the only corroded plates being six about each of the Kingston valves, one plate on the starboard side in contact with the stern being roughened, but not pierced, and one on the port side forward, just below and in contact with the ram. Besides these there were a few plates which had been indented and torn slightly, probably through colliding with some object. In addition I found that one sheet had been removed from the garboard strake on the port side, about 60 feet aft. I could not learn why this plate had been taken off.

The history of this copper, so far as I could gather it, is as follows: The Trenton was in commission in Europe for some years, and on her return in October, 1881, she was laid up at the New York Yard. I am informed by her commanding officer, Captain F. M. Ramsay, U. S. N., that when she was brought in she was laid alongside the iron derrick, and she was so heavily loaded that it was with great difficulty that she could be forced into the mud bank under the derrick. After lying there some time she was drawn out into the Wallabout, and from that time until she was put into the dry dock in December, 1882, she lay nearly opposite the mouth of the Brooklyn sewer. The conditions, then, to which her old copper was subjected were almost identical with those to which the Juniata's new copper was subjected, the chief difference being that as the Trenton was heavily loaded, while the Juniata was light, the Trenton probably sank much deeper in the mud bank than the Juniata did.

On December 20, 1882, in obedience to orders, I proceeded to Washington to inspect the rolling mill at the Washington Navy Yard, then in operation. Here I witnessed the operations of hot rolling and scaling, and my attention was particularly attracted to the latter process, as it did not seem to be complete, some portions of the scale being adherent after the removal from the bath, necessitating the cleaning of the sheet as completely as possible by mechanical means. As the treatment with the lye and acid was done in a very crude way, by rubbing on with a broom, this may account in a measure for the failure to entirely remove the scale or oxide. During my visit I was the recipient of courteous attentions from Commodore T. Pattison, U. S. N., commanding, and from Naval Constructor S. H. Pook, U. S. N., in charge of the rolling-mill, and the latter permitted me to take copies of letters, of recent date, from the managers of some of the principal rolling-mills in the country, from which I extract the following:

Park, Scott & Co., Lake Superior Copper Mills, Pittsburgh, Pa., say: "The rolls in our mills which have given the most satisfaction are semi-steam-chilled." "We are not experienced as to what action sea water may have on sheathing made with iron rolls."

C. G. Hussey & Co., Pittsburgh Copper and Brass Rolling Mills, Pa., state: "For rolling copper we use principally the chilled iron rolls, and as far as our experience has gone we find them well adapted for the work. We never knew of any iron from the rolls adhering to the copper, but black spots may be on the copper from imperfect removal of the scale or oxide. That is the only way we can account for black spots or marks."

Hendricks Brothers, New York, write: "We consider chilled-iron rolls the best for the purpose referred to, and when replacing any at our own works, do so with those of that description. The rolling of copper in iron rollers is not detrimental for sheathing, nor would they injure it in any way as regards the action of sea water. The black spots spoken of are not iron, but copper scale or oxide, and do not affect the quality. Copper may be of equal purity, but some are harder than others; the latter are preferred for the sheathing for vessels, on account of the action of salt water upon it."

Pope & Cole, Baltimore, Md., write: "The only suitable material for the construction of rolls for rolling copper is *best iron, chilled.* The arrangements for rolling copper at the Washington Navy Yard are, in our judgment, so good that some time since we availed of permis-

sion from headquarters to make copies of the working drawings in your mill, with the purpose of constructing one here, upon your method, in place of our present mill. The methods and surroundings of rolling copper have nothing whatever to do with the action of sea water upon copper sheathing on vessels. The trouble in cases where copper sheathing has become *honeycombed* or *quickly worn thin* when in contact with sea water is attributable to the fact of the presence of a little silver in copper, which is quickly attacked by salt water. Copper for rolling can be procured which has no silver whatever in it—not a trace. The black specks or spots which you referred to are not iron: they are the oxide of copper. Copper and oxygen have a wonderful affinity for each other, especially when copper is hot or in a molten state. The oxide of copper, or, as known in commerce, "copper scale," is easily removed from sheets by "pickling," and ought to be wholly removed before your sheets are cold-rolled. If you will heat a piece of bright polished copper and then expose it for one moment to the atmosphere, it will so quickly absorb oxygen therefrom as at once to become as black as iron."

During this visit I received the following information from the executive officer of the Powhatan. "The Powhatan was lying at the wharf of the Brooklyn Navy Yard, near the iron derrick, from November 15, 1879, to January 23, 1880, and from December 23, 1880, to March 24, 1881. Shortly after each of the above occasions of her stay off the Navy Yard she went into the dry dock, and upon examination the copper on the bottom of the vessel was found in perfectly good condition." The conditions of exposure of the Powhatan evidently differed from those of the Juniata only in the fact that the latter was lying in the Wallabout during the summer months, while the former was there during the winter. This would to an extent probably modify the action.

On December 28, 1882, Commodore Pattison, U. S. N., sent me the following samples: Ingot copper, Pope & Cole; ingot copper, Hendricks Bros.; copper cake, Pope & Cole; copper cake from refuse copper refined at the Washington Navy Yard. The ingot copper from Pope & Cole was full of air-holes; the rest of the samples were sound, fine-grained, and quite free from air-holes or cavities, the specimen from the Washington Navy Yard being especially so.

On December 12, 1882, I received the following letter:

BUREAU OF ORDNANCE, NAVY DEPARTMENT,
WASHINGTON CITY, *December* 11, 1882.

Professor CHARLES E. MUNROE, *Chemist, U. S. N. Academy.*

Sir:—In connection with the condition of the copper sheathing on the Brooklyn, I beg leave to say (as probably throwing some light on the subject) that the copper on the ferryboat Billow, at the Torpedo Station, put on in May last, is very badly pitted.

This metal was furnished by the Bureau of Construction and Repairs, and the following analysis made* at the Torpedo Station shows that it contains foreign matters:

	Per Cent.
Copper	98.492
Lead	0.172
Arsenic	0.290
Nickel	0.102
Cobalt	0.010
Iron	0.570
Oxygen	0.240
Zinc	0.272
	100.148

Also traces of silver and antimony.

This copper may have been taken from the same lot from which the Brooklyn was coppered. The Bureau will be glad to make other analyses of copper, if desired. I am, sir, your obedient servant,

MONTGOMERY SICARD,
Chief of Bureau.

In reply to my inquiry as to the conditions to which the Billow had been subjected, Capt. T. O. Selfridge, U. S. N., commanding the Torpedo Station, states that "the Billow never has been aground since the copper was put on, and that she has only been exposed to the action of pure sea water."

Learning that there had formerly been trouble from the water of Baltimore Harbor, I addressed a prominent shipbuilding firm there, and received the following reply:

BALTIMORE, MD., *December* 14, 1882.

C. E. MUNROE, *Professor, U. S. Naval Academy.*

Dear Sir:—Replying to your favor of 9th instant in reference to the corrosion of copper and metal on vessels' bottoms in Baltimore Harbor, we would state that previous to the stopping of the sugar refineries and the deepening of our harbor, all the steamboats whose landings were in the vicinity of the refinery or at the foot of the street where the sewage of the latter was discharged,

* By Professor J. Fleming White.

suffered very much, and had to be docked for repairs or renewal of metal once each year, and in some cases at the refinery wharves twice in one year. The metal would be eaten worst at the water line around the nails in the seams of the plates. Some of the boats that used iron for protection against ice put it on in the fall and had to remove it in the spring, because it would be eaten away at the water line and interfere with the boats running. All these boats now run two, three and four years without docking, and, if they have pure copper on, we find it good after four years. We have some cases that we attribute to inferior metal. One we have just completed, the ship St. Albans, engaged in the Atlantic trade, metal been on twenty-six months, in active use eighteen months, honeycombed badly and had to be removed; should have lasted forty months. Yours respectfully, etc.,

WILLIAM E. WOODALL & CO.

In considering the case of the Juniata we must bear in mind that it is to be expected that copper sheathing will corrode in use, and that the peculiar advantage which it offers for keeping a ship's bottom clean is due to the fact that the copper is acted upon by sea water and forms a salt which, as it dissolves or scales, carries off the barnacles or seaweeds with it, and that this corrosion goes on over the whole immersed surface and continues throughout the whole period of immersion.

What takes place with sound copper in pure sea water will occur in any solvent in which the copper is immersed. If there is no contact with other bodies, solid or gaseous, and no marked currents formed in the liquid, corrosion will take place equally over the whole surface of the copper, though the speed of the corrosion may differ with the solvents.

What is peculiar about the corrosion of the Juniata's copper is that it was local and abnormally rapid. We will now take up the various theories proposed to account for this.

1 and 4. That it was due to contact with iron.

On January 22, 1824, Sir Humphry Davy said: "The rapid decay of the copper sheathing of His Majesty's ships of war, and the uncertainty of the time of its duration, have long attracted the attention of those persons most concerned in the naval interests of the country. Having had my inquiries directed to this important object by the Commissioners of the Navy Board, and a Committee of the Royal Society having been appointed to consider of it, I entered into an experimental investigation of the causes of the action of sea water on copper.

"It has been generally supposed that sea water had little or no

action on pure copper, and that the rapid decay of the copper on certain ships was owing to its impurity. On trying, however, the action of sea water upon two specimens of copper sent by John Vivian, Esq., to Mr. Faraday for analysis, I found the specimen which appeared absolutely pure was acted upon even more rapidly than the specimen which contained alloy; and on pursuing the inquiry with specimens of various kinds of copper which had been collected by the Navy Board and sent to the Royal Society, and some of which had been considered as remarkable for their durability, and others for their rapid decay, I found that they offered very inconsiderable differences only in their action upon sea water; and, consequently, that the changes they had undergone must have depended upon other causes than the absolute quality of the metal.

"When a piece of polished copper is suffered to remain in sea water, the first effects observed are a yellow tarnish upon the copper and a cloudiness in the water, which take place in two or three hours. The hue of the cloudiness is first white; it gradually becomes green. In less than a day a bluish-green precipitate appears in the bottom of the vessel, which constantly accumulates, at the same time that the surface of the copper corrodes, appearing red in the water, and grass-green where it is in contact with air."

Pursuing his experiments, Davy showed that there must be free oxygen present in water in order that copper might corrode, for "copper in sea water deprived of air by boiling or exhaustion, and exposed in an exhausted receiver or an atmosphere of hydrogen gas, underwent no change, and an absorption in atmospherical air was shown when copper and sea water were exposed to its agency in close vessels."

From his investigations Davy ascertained that when copper, in contact with a metal which was electro-negative to it, was exposed to sea water, the electro-negative metal was attacked, and the copper was free from corrosion until the other metal was destroyed; and he proposed to protect sheathing by this means. "In pursuing these researches and applying them to every possible form and connection of sheet copper, the results were of the most satisfactory kind. A piece of zinc as large as a pea, or the point of a small iron nail, was found fully adequate to preserve forty or fifty square inches of copper, and this wherever it was placed, whether at top, bottom, or in the middle of the sheet of copper; and whether the copper was straight, or bent, or made into coils. And where the connection between

different pieces of copper was completed by wires, or thin filaments of the fortieth or fiftieth of an inch in diameter, the effect was the same: every side, every surface, every particle of copper remained bright, whilst the iron or the zinc was slowly corroded.

"A piece of thick sheet copper containing on both sides about sixty square inches was cut in such a manner as to form seven divisions, connected only by the smallest filaments that could be left, and a mass of zinc of the fifth of an inch in diameter was soldered to the upper division. The whole was plunged under sea water; the copper remained perfectly polished. The same experiment was made with iron; and now after the lapse of a month, in both instances, the copper is as bright as when it was first introduced, whilst similar pieces of copper undefended in the same sea water have undergone considerable corrosion, and produced a large quantity of green deposit in the bottom of the vessel.

"A piece of iron nail about an inch long was fastened by a piece of copper wire nearly a foot long to a mass of sheet copper containing about forty square inches, and the whole plunged below the surface of sea water; it was found, after a week, that the copper defended the iron in the same manner as if it had been in immediate contact.

"A piece of copper and a piece of zinc soldered together at one of their extremities were made to form an arc in two different vessels of sea water, and the two portions of water were connected together by a small mass of tow moistened in the same water; the effect of the preservation of the copper took place in the same manner as if they had been in the same vessel." (*Phil. Trans.* 1824, p. 151.)

On p. 242 *Phil. Trans.* 1824 Davy gives a report of additional experiments on the protection of copper sheathing. He says: "Sheets of copper defended by from $\frac{1}{40}$ to $\frac{1}{1000}$ part of their surface of zinc, malleable and cast iron have been exposed for many weeks in the flow of the tide in Portsmouth Harbor, and their weights ascertained before and after the experiment. When the metallic protector was from $\frac{1}{40}$ to $\frac{1}{150}$, there was no corrosion nor decay of the copper; with smaller quantities, such as from $\frac{1}{200}$ to $\frac{1}{400}$, the copper underwent a loss of weight which was greater in proportion as the protector was smaller; and, as a proof of the universality of the principle, it was found that even $\frac{1}{1000}$ part of cast iron saved a certain proportion of the copper.

"The sheeting of boats and ships protected by the contact of zinc, cast and malleable iron in different proportions, compared with that

of similar boats and sides of ships unprotected, exhibited bright surfaces, whilst the unprotected copper underwent rapid corrosion, becoming first red, then green, and losing a part of its substance in scales.

"Fortunately, in the course of these experiments it has been proved that cast iron, the substance which is cheapest and most easily procured, is likewise most fitted for the protection of copper. It lasts longer than malleable iron or zinc; and the plumbaginous substance which is left by the action of sea water upon it retains the original form of the iron, and does not impede the electrical action of the remaining metal."

In *Phil. Trans.* 1825, p. 328, Davy gave the results of his "Further Researches on the Preservation of Metals by Electro-Chemical Means." He said: "As long as the whole surface of the copper changes or corrodes, no such adhesions (barnacles, etc.) can occur; but when this green rust has partially formed, the copper below is protected by it and there is an equal action produced, the electrical effect of the oxide, submuriate and carbonate of copper formed being to produce a more rapid corrosion of the parts still exposed to sea water; so that sheets are often found perforated with holes in one part, after being used five or six years, and comparatively sound in other parts.

"There is nothing in the poisonous character of the metal which prevents these adhesions (barnacles, etc.). It is *the solution* by which they are *prevented—the wear* of the surface. Weeds and shell fish readily adhere to the poisonous salts of lead which form upon the lead protecting the fore part of the keel; and to the copper, in any chemical combination in which it is insoluble.

"In general, in ships in the Navy, the first effect of the adhesion of weeds is perceived upon the heads of the mixed metal nails, which consist of copper alloyed by a small quantity of tin. The oxides of tin and copper which form upon the head of the nail and in the space round it defend the metal from the action of sea water; and being negative with respect to it, a stronger corroding effect is produced in its immediate vicinity, so that the copper is often worn into deep, irregular cavities in these parts.

"When copper is unequally worn, likewise in harbors or seas when the water is loaded with mud or mechanical deposits, this mud or these deposits rest in the rough parts or depressions in the copper, and in the parts where the different sheets join, and afford a soil or

bed in which seaweeds can fix their roots, and to which zoophytes and shell fish can adhere.

"As far as my experiments have gone, small quantities of other metals, such as iron, tin, zinc or arsenic in alloy in copper, have appeared to promote the formation of an insoluble compound on the surface, and consequently there is much reason to believe must be favorable to the adhesion of weeds and insects."

Up to July, 1824, all Davy's experiments had been tried in harbor in comparatively still water, but soon after the protectors were tested on a steam vessel in the North Seas, and it was found that sheets of unprotected copper one foot square lost about 6.55 grains in passing at a rate of eight miles per hour in twelve hours; but a sheet of the same size defended by rather less than $\frac{1}{100}$ lost 5.5 grains, and like sheets defended by $\frac{1}{70}$ and $\frac{1}{100}$ of malleable iron each lost 2 grains. These experiments show that there is a mechanical wear of the copper in sailing, and which, on the most exposed part of the ship and in the most rapid course, bears a relation of nearly 2 to 4.55. The copper sheets used weigh from 7000 to 8000 grains, and the balance would detect a difference of $\frac{1}{100}$ of a grain in carrying this load.

Further experiments showed that when air was excluded from a vessel containing sea water in which iron and copper or other corrodible metals were immersed, no action took place, and that the addition of an alkaline substance, even in presence of air, was sufficient to arrest corrosion; but if the solution was *strongly* alkaline, then the electro-chemical action was reversed and the copper was corroded while the iron was preserved. The results of applying protecting masses of iron to coppered ships are cited, and the effect seems to have been advantageous; but no instance is given where it had been tested for any long period.

In closing he says: "The copper used for sheathing should be the purest that can be obtained; and in being applied to the ship, its surface should be preserved as smooth and equable as possible; and the nails used for fastening should likewise be of pure copper; and a little difference in their thickness and shape will easily compensate for their want of hardness."

In the *Comptes Rendus*, **59**, 15; 1864, M. Becquerel reviews Davy's work, and records the work which he himself carried on at Toulon under the direction of the Minister de la Marine, which confirmed the views as to the protective action of iron on copper when immersed in sea water.

In the *Trans. Inst. Nav. Arch.* **10,** 166; 1869, John Grantham, Benjamin Bell, Charles Lamport, John Scott Russell and C. F. J. Young, all testify to the destruction of iron in contact with copper, and the latter quotes Faraday, Wood, Normandy, Selwyn and Siemens in support of his views. These conditions, however, only hold true for sea water in an acid or neutral condition. At the time of my visit to the Wallabout I found the water and mud slightly acid, and if this be the prevailing condition of the Wallabout, it is impossible that the corrosion of the copper could have been due to the presence of iron.

But while this relative action holds good for acid and neutral solutions in general, in most alkaline solutions, and especially solutions of the alkaline sulphides, the reverse is true, and the copper becomes electro-positive and is dissolved, while the iron remains unacted upon. Davy pointed this out in 1812 (*Chemical Phil.*, p. 148), and again in 1825 (*Phil. Trans.*, p. 339); and Faraday, in his *Experimental Researches in Electricity*, Vol. II, p. 86, gives tables of the electro-chemical series for different solutions which show these facts. In order to test these statements I made experiments, taking solutions of ammonium carbonate and Severn-River water, and ammonium sulphide and Severn water. In each of these I inserted a strip of iron and one of copper in contact with each other and allowed them to stand. In 24 hours there was evidence of corrosion on the copper, and in one case where the action had gone on for two months the copper was eaten off to the surface of the liquid, and copper was deposited on the iron. The solution contained 10 cm. of yellow sulphide of ammonia of the ordinary strength to 200 cm. of water, and during the time spoken of the solution was in an open flask in a dimly-lighted hood. No quantitative experiments were made, since it was not important for this research in the case of the ammonium carbonate, and in the case of the ammonium sulphide the coating of sulphide on the copper made it difficult to determine the loss with any degree of accuracy.

In determining if such a condition of circumstances could occur in the Wallabout, we may learn something from the examination of the sewage waters and mud. The sewage water taken at the mouths of the sewers was collected in patent-stoppered lager-beer bottles, which were carefully rinsed with the water to be collected. Although tolerably free from odor when collected, by the time they reached Annapolis they were highly charged with gases, which proved to be

largely sulphide of hydrogen and some sulphide of ammonium. Through the decomposition they had become much more turbid from suspended matter than when first collected. So great was the pressure upon the bottles that, though they were kept in a cool place, one of them burst under the pressure of the confined gases. The sewage had become alkaline when it reached Annapolis. I give below the analyses of these waters, filtered, and of the sedimentary matter, and I add an analysis of the Severn-River water, since I used this in some of the experiments. The analyses given hereafter are usually the mean of several:

Parts in 100,000.

	Solids.			Ammonia.		
	Vol.	Non-vol.	Total.	Am.	Al. Am.	Salt.
Williamsburgh.....	261.6	583.6	845.2	.1420	.1250	385.5
Brooklyn.....	118.6	160.8	279.4	.0758	.0472	135.2
Severn.....	157.0	1236.0	1393.0	.....	.....	1054.7

SUSPENDED MATTER.

Parts in 100,000.

	Vol.	Non-vol.	Total.
Williamsburgh	31.2	84.0	114.2
Brooklyn	22.6	38.1	50.7

The result of such sewage as the above flowing into salt water must be, not only the production of mud banks, as stated above, but also the generation of hydrogen sulphide and alkaline sulphides, for the salt water contains calcium sulphate (in pure sea-water it will rise to 100 parts in 100,000), and when organic matter comes in contact with this, calcium sulphide is formed, which gives off its sulphur as hydrogen sulphide when it comes in contact with the carbon dioxide of the air. Ammonium sulphide will then be formed through reaction with the sewage.

MUD.

The mud was stored in new paint-kegs immediately after collecting, and on arrival here it was transferred to air-tight glass jars. When the mud from under the iron derrick was dried, it was of a bluish-white color and contained a considerable number of shells. It effervesced somewhat with acids, and when moistened it had a clay-like appearance. On drying, it gave off a slight offensive odor of animal matter. The mud from off the ordnance dock appeared, on drying, to be a mixture of blue mud with coal tar, and gave off the

odor of coal tar on drying. The mud from the iron derrick lost 15.23 per cent. of volatile matter on ignition, while the mud from the ordnance dock lost 24.51 per cent. When treated with ether, both yielded a yellow extractive matter, which on evaporation gave off an acrid odor. Both samples after exposure became alkaline.

We see, then, that in the sewage emptying into the Wallabout we have materials for the formation of ammonium and other sulphides, and that, although at the time of my visit there the water was acid to neutral, yet, under the varying conditions prevailing, it is possible there are times when it may be alkaline. Is it, then, probable that iron in alkaline solution was the cause of corrosion? I think not, and for the following reasons:

If iron had fallen into this mud bank, it is probable that owing to its greater relative weight it would sink through the soft mud to the bottom. Now, there was considerable difference in height between the corroded plates highest up on the hull and those on the keel, and if the Juniata touched bottom on the keel, the iron in contact with the higher plates must have been buoyed up. Since, however, there was room for the much heavier Trenton to get in, it is probable that the Juniata did not touch hard bottom. This argument may, however, be met by supposing that both the vessels lay on the flat of the bilge in a trough in the bottom of the Bay.

Another consideration is that the corrosion is too local for simple contact. None of the holes were over two inches in diameter, nor the roughened spaces about them more than eight inches. Now, copper is a good conductor, and with sheets as thick as these it seems strange that the action should be confined to so small an area. I do not lay much stress on this point.

What seems to me conclusive is that both the Powhatan and the Trenton lay in the same berth without injury, and that the copper on the rudder of the Juniata and the goring-piece on the keel were under precisely the same conditions as the remainder of the copper on the Juniata, and they were not corroded; and finally, that the copper on the Billow was corroded in a similar way without having been exposed to like surroundings.

2. That it was due to sewage. Since household sewage may contain sodium carbonate and hyposulphite from the soap used, and zinc chloride and bleaching powder from the disinfectants employed, I tested the action of these substances upon both copper and oxide of copper, the substances and the solutions being enclosed in stoppered bottles. The following are the results after seven months' action:

Copper and sodium hyposulphite—copper coated with sulphide—no copper in solution.

Copper oxide and sodium hyposulphite—no copper in solution.

Copper and sodium carbonate—copper coated with green carbonate—considerable copper in solution.

Copper oxide and sodium carbonate—faint trace of copper in solution—the copper oxide unchanged in appearance.

Copper and zinc chloride—deep green deposit of copper chloride on sides of bottle—copper bright.

Copper oxide and zinc chloride—no action.

Copper and bleaching powder—copper coated with bluish coat—copper in solution.

Copper oxide and bleaching powder—trace of copper in solution.

All of these substances act upon the copper, but the last two would be destroyed by the organic matter in the Wallabout, and the first two would probably not exist any length of time in their original condition. But granted that any of them were present and free to act, or that there were free acids or ammonia or ammoniacal salts present, could they produce such corrosion as took place on the Juniata? In my opinion not, because they would be dissolved in the water or in a layer at the surface, and would produce corrosion over the entire immersed portion of the copper or else at the water line, while that of the Juniata was purely local and confined to widely and irregularly separated spots.

3. That it was due to impurities in the copper arising from imperfect refining, impure ores, or the intentional admixture of foreign and cheaper metals.

In the paper by Davy quoted above, it will be seen that the presence of iron, tin, zinc, arsenic and the like, in small quantities, promoted the formation of insoluble scale on copper. In Pope and Cole's letter we see that they attribute corrosion to the presence of silver. This view was advanced by A. A. Hayes (*Am. Jour. Sci.* [2] **11**, 324). He says: "Some analyses I made, many years since, of sheathing copper which had long resisted the action of sea water proved the presence of one ten-thousandth part of silver. It was found that even this small portion of silver sensibly modified the chemical relations of the metals, and observations had indicated that the quality for sheathing was improved. Copper of this kind is frequently met with in commerce, and is derived from the Chilian ores of copper, which, although argentiferous, do not yield enough silver to render its separation economical.

"An occasion offered for again examining this subject, when the argentiferous native copper of Lake Superior was first refined and rolled by the Revere Copper Co., more than five years since, and the results have lately been obtained. Four suits of sheathing, for large merchant vessels, formed the subjects for observations, the metal being of uniform composition, as determined by assay of the clipping from many sheets. Two thousand parts of the alloy contained four parts of pure silver, or the standard ton of this country contained four pounds of silver (0.20 per cent.).

"A *proximate* analysis of this metal was also made, and it proved to be pure copper throughout, the mass of which, an alloy of silver and copper, was evenly distributed so as to form either a mixture or a compound alloy, in which one part of the copper is truly combined with the silver, and the other and larger part simply combines with the alloy. This is a very common constitution of alloys, in which two metals exist without any metalloid occurring to disturb the simplicity of the union, and always indicates a careful purification of the metals.

"It was assumed as probable that the silver alloy would close the pores of the copper, which takes place with a tin alloy in bronze, and, in a mechanical way, confers durability. If, however, corrosion should take place, it was in accordance with observed cases that the silver alloy would act as a negative element, and the copper alone would be removed. How erroneous these inferences proved will be seen in the detail of the results.

"The Chicora was coppered January 9, 1847, taking 7392 pounds of metal, which was fastened by bronze nails. She was employed in trade to China, and wore her copper so rapidly that it was removed in March, 1849, 2628 pounds only remaining. In this case the sheets, after the usual operations, had been consolidated by 'cold-rolling.'

"The Serampore was coppered January 18, 1847, requiring 8447 pounds of 'cold-rolled' metal, secured by bronze nails. She sailed to China and home *via* Cape of Good Hope, and to the Pacific and home *via* Cape Horn, requiring new copper in March, 1850. The weight of the remaining copper was not ascertained.

"The Hamilton was coppered October 22, 1847, requiring 7706 pounds metal, secured by bronze nails. The sheets used were in the ordinary or annealed state. This vessel was employed in the India trade, and wore out her copper in August, 1849. The weight of the copper remaining was 3086 pounds.

"The Carthage was coppered November 26, 1847, requiring 8727 pounds 'cold-rolled' metal, fastened by bronze nails. She was employed in the India trade, and her sheathing was destroyed in August, 1849. The copper remaining weighed 5810 pounds.

"Omitting the case of the Serampore, where the corrosion cannot be determined by weight, we have the loss in every one hundred parts of metal, for the time of duration, thus: The Chicora, twenty-seven months, lost 64.45 per 100; the Hamilton, twenty-three months, lost 59.95 per 100; the Carthage, twenty-one months, lost 33.45 per 100.

"Allowing the same rate of corrosion, and taking the time as twenty-seven months for each: The Chicora lost 64.45 in 100; the Hamilton lost 70.38 in 100; the Carthage lost 43.00 in 100.

"In the cases of the Hamilton and Carthage we perceive the influence of the different processes of manufacturing the sheets on the durability of the copper. By the operation of 'cold-rolling' the surfaces of the sheets are rendered very compact, and in any corroding solution they bear a negative relation to the metal in the same sheets between these surfaces. Such copper is also always strongly negative to annealed copper in acid solutions until the hardened surfaces are removed; it then loses this relation. The Hamilton exhibits the greatest effect of sea-water action on the annealed alloy, while in the Carthage the protecting influence of the hardening surface was exerted nearly to the time her copper was removed. These observations establish the fact of the rapid corrosion of an alloy thus constituted, and show its entire unfitness for sheathing purposes.

"The average duration of copper sheathing decreases slightly as the requirement of greater speed in sailing is more urgent. Taking one hundred merchant ships, sailing on different oceans, the average duration now on American ships is three years.

"On the point of the *kind* of corrosion following the exposure of the alloy to sea water and air, the information obtained of these trials is of a definite character. Part of the sheets remaining, and an ingot of the copper from smelting a large quantity, were assayed, and the results showed that the same proportion only of silver remained as was originally contained in the alloy. The silver, therefore, by taking the negative state in the mass of the metal alloy hastened its destruction, while its own form and condition were such that it separated as the copper was corroded."

In this connection I made the following analyses. In these analyses I designate the copper from the rudder of the Juniata as "rudder copper," that taken from the Juniata after corrosion as "old Juniata copper," that taken off from the Brooklyn, in order to put on her present suit, as "Brooklyn copper," and the new sheet from the New York storehouse as "new Juniata copper."

In the analyses of the coppers, I have followed the methods given by Andrew A. Blair, chemist to the United States Board for Testing Metals, which appear as an appendix to Ex. Doc. 98 of the Forty-fifth Congress, Second Session; and I have also employed the method of W. Hampe, given in *Zeitschrift für Analytische Chemie*, 176, 1874, and in Watts' *Dictionary of Chemistry*, Vol. VIII, Part I. The methods have sometimes been modified in a measure, to accommodate them to the appliances at hand. In the table, the "rudder copper" is No. 1; the "Brooklyn," No. 2; the "new Juniata," No. 3, and the "old Juniata," No. 4. The results given are the mean of a number of determinations:

	1.	2.	3.	4.	
Copper,	99.428	99.225	98.426	98.509	per cent.
Silver,	.125	.085	.005	.010	
Arsenic,	trace.	none.	.135	.159	
Antimony,	none.	none.	.008	.005	
Lead,	.010	.080	.178	.152	
Iron,	.183	.252	.650	.580	
Nickel,	none.	none.	.050	.010	
Zinc,	none.	none.	.170	.150	
Bismuth,	.005	.003	.012	.015	
Oxygen,	.155	.185	.280	.235	
	99.906	99.830	99.914	99.825	

For comparison with these, I have sought to obtain analyses of different American coppers from the principal sources, in order that we might determine what would be termed "pure copper" in commerce here, but I have been unable, as yet, to obtain such, so I give (1) an analysis of a "refined copper," from Oker, made by Hampe, and reported in Fresenius' *Quantitativen Chemischen Analyse*, **2**, 527; 1882; (2) an analysis of a "refined copper" from Colorado, made by T. Egleston, Ph. D., and given in *Trans. of American Institute of Mining Engineers* for October, 1882; (3) an analysis of "ingot Lake Superior copper," Andrew A. Blair, *loc. cit.* 295.

	1.	2.	3.
Copper,	99.325	99.705	99.420 per cent.
Silver,	0.072	0.135	0.014
Gold,	0.0001	...	...
Arsenic,	0.130	0.091	none.
Antimony,	0.095	...	none.
Bismuth,	0.052	...	none.
Lead,	0.061	none.	trace.
*Iron,	0.063	0.031	0.013
Cobalt,	0.012	...	...
Nickel,	0.064	...	...
Sulphur,	0.001	trace.	...
Oxygen,	0.1166	...	...
Tellurium,	...	0.083	...
Zinc and nickel,	...	0.024	...
Suboxide of copper,	...	...	0.537
Carbon,	...	...	0.041
	99.9917	100.069	100.025

The Juniata copper, then, is not so pure as the rudder copper or the Brooklyn copper, or the copper last cited. The excess of silver in the rudder and Brooklyn coppers may at first excite remark, but we must remember that both of these coppers had been exposed to sea water for a very long time, and that sea water contains chloride of silver in solution, and that silver will be deposited upon copper under these circumstances. Mulder, in his *Die Silber-Probirmethode*, 27, states that chloride of silver is soluble in solutions of all the metallic chlorides which are soluble in water. Watts' *Dictionary of Chemistry*, **5**, 271, states that silver has been detected in sea water, and refers to *Ann. Ch. Phys.* [3] **27**, 129, which I have not been able to consult, and T. Sterry Hunt, *Chem. and Geol. Essays*, 231, repeats this statement. To test it, I placed some freshly precipitated and

*In examining the copper for iron, I deemed it important to test the nitric acid used, although it was bought, as chemically pure, through Desaga, of E. Merck, of Darmstadt. The first bottle examined was but partially full, and had been standing for some time in strong sunlight, and was evolving nitrous fumes, notwithstanding that the glass was of a dark green color. Analysis showed it to contain .00135 gram of iron in 100 cm. Another full bottle of the same lot, which had been standing in the dark, was tested, and was found to be free from iron. This last was used in the analyses.

washed chloride of silver in Severn water and inserted a strip of copper. In twenty-four hours a decided coating of silver was deposited on the copper.

The amount of silver present in the Juniata coppers seems, however, too small to have been the source of this trouble, and of the other substances found, the oxygen appears the one most likely to have been the cause of the trouble. It should be said that the darker, spotted portions of the new sheets were taken for analysis, and that on especially removing the surface from some of these spots by the aid of a bright steel file-scraper, I found it to consist of a film of oxide free from sulphide. But as from the first my attention and that of others had been called to this unusual feature in the copper, and as these spots closely resembled the corroded spots in form, it seemed proper to select these portions. I am not, however, assured that the oxide originally existed in the copper.

The following experiments were made to ascertain if corrosion would take place between copper and copper oxide in the presence of the materials in the Wallabout. Heavy, cold-drawn copper wire was cut into pieces. Each piece was then bent, and one end was heated in the flame until it was coated with oxide. The strips were then immersed in the solutions or buried in the mud, as given in the table below. We then had an electro-chemical couple with copper and oxide of copper. In the experiments cited below, No. 5 and No. 6 were the most satisfactory as regards the cleanliness of the copper after removal from the solution and washing:

Substance Used.	Loss.	Remarks.
1. Copper and Williamsburgh sewage.	1.42 per cent.	Liquid alkaline—contained coal tar.
2. Copper oxidized and Williamsburgh sewage	1.45 "	Liquid alkaline—contained coal tar—copper pitted.
3. Copper and Brooklyn sewage	3.42 "	Liquid faintly alkaline.
4. Copper oxidized and Brooklyn sewage	2.99 "	Liquid faintly alkaline—copper pitted.
5. Copper and mud from under shears and Severn water	7.24 "	Liquid faintly alkaline—no pitting.
6. Copper oxidized and mud from under shears and Severn water	14.64 "	Liquid faintly alkaline—copper badly pitted.
7. Copper and mud from Ordnance Dock and Severn water	4.06 "	Liquid alkaline—no pitting.
8. Copper oxidized and mud from Ordnance Dock and Severn water	3.06 "	Liquid alkaline—copper faintly pitted.

As in these cases the solutions were all slightly alkaline, I repeated the experiments with Severn-River water, and with common-salt solutions, and in each case the copper was corroded. In addition, I connected my couple with a galvanometer and got a marked deflection of the needle. Hence there can be no doubt that electrochemical action can go on between copper and copper oxide in sea water. This view is supported by the fact that all authorities are agreed that the corrosion of pure copper by pure sea water cannot take place in the absence of air. This air supplies oxygen, and the first step in the process of corrosion is one of oxidation. If, then, the copper be oxidized when immersed, the process is facilitated.

5. That it was caused by the adhesion of coal tar. In the examination of the Juniata, no coal tar was observed in contact with the corroded spots, though small amounts were noticed elsewhere, the copper at those points being sound. In the experiments last cited, when coal tar was present it adhered to the copper so firmly that it was difficult to remove it, and it formed a strongly adherent varnish or lacquer which seemed to protect the copper from corrosion.

6. That it is due to physical or chemical differences in different parts of the copper which were caused by the method of manufacture. From the consideration of all the circumstances, and especially of the facts that the copper is found to be *spotted* with oxide; that these spots are irregularly distributed over the plates; that they generally agree in configuration and size with the corroded spots, and that the copper at the corroded spots appears laminated, I am led to conclude that this theory is the more probable one, and that the imperfections result from blister-holes in the copper and the incomplete removal of the scale.

We have found that in the existence of these spots of scale or oxide we have a condition which is favorable to the commencement of the corrosion. Why does it continue?

If we examine one of the corroded spots from which the surface has been removed, we find that the remaining surface is roughened. Now, such a surface is more readily attacked than a polished surface. This latter is a well-known fact in connection with the "rusting" or corrosion of metals, and it is for this reason largely that metal articles are polished. But it seems to me that there is an additional reason for action at this point. In the *Proc. Nav. Inst.* **8**, 502 I have shown that annealed steel is much more soluble in sea water than "tempered" or hardened steel, and that when in contact the soft metal is rapidly

corroded. I have recently been confirmed in the truth of my observations by the investigation of M. Gruner in *Comptes Rendus*, 96, 195. I am inclined to the opinion that the same holds true of copper of varying hardness, and I find support for my opinion in the statement of A. A. Hayes.* I believe that the copper beneath the spots of scale is softer than that about it, and furnishes the differences necessary for this action.

My theory to account for the existence of these differences and for the formation of the spots is as follows: I assume that an unsound cake of copper is taken for rolling which contains cavities like those seen in the ingot from Pope & Cole. When this is rolled into a bar, the cavities will be extended in the direction of the length of the bar. When the pieces of bar are afterwards rolled into sheets, these cavities will also be extended in the direction of the width of the sheet. These changes in form would of course be irregular, and would tend to produce such shapes as were seen on the copper. These cavities would necessarily contain gas, and copper is a very excellent conductor of heat, while gases are as a rule very poor conductors. Then, when the whole is heated and allowed to cool, the space about the cavity would be longer in cooling than the remainder, and, as a consequence, more scale would be formed at that point than elsewhere, and might adhere more firmly, or its formation might continue after the scaling process was considered complete. This layer of oxide and cushion of gas would then prevent the copper at this point from becoming as hard, through rolling, as over the remainder of the surface. The fact that the copper appears slightly laminated at some of the corroded spots seems to substantiate this theory. It may be objected that an enclosed gas at the high temperature of the operation would exert pressure sufficient to burst the envelope, but we must remember that the cavities were formed when the gas was at the temperature of molten copper.

In conclusion, I would state that in my opinion the corrosion of the Juniata's copper was due principally to the presence of spots of oxide of copper on the surface of the plates at the time they were put on, and I would recommend in the future the use of a pure copper, care in the production of sound cakes, and careful removal of the scale.

* *Loc. cit.*

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A PRACTICAL METHOD OF ARRIVING AT THE NUMBER, SIZE, TYPE, RIG, AND COST OF THE VESSELS OF WHICH THE U. S. NAVY SHOULD CONSIST IN TIME OF PEACE.*

By Lieutenant-Commander F. M. Barber, U. S. N.

There is but little doubt of the fact that it is utterly impossible to-day to reconcile the ideas of different naval officers as to the size, rig, number, or types of vessels which we require, and that there is really no safe rule for a Congressional committee to be guided by in recommending the adoption of any type of ships, or the appropriation of money to pay for them.

The first Advisory Board recommended a large number of ships, the plans and calculations of which were scarcely worked out before it ruined itself by a minority report. The second Advisory Board proposed ships differing entirely from those recommended by either the majority or minority of the first board; and, finally, the third (or Walker Board so-called) has recommended ships differing in most features from those recommended by the second board; and, lastly, Mr. Whitney has procured some entirely new plans from abroad. These differences naturally arise: 1st. From the immense variety of ideas that modern mechanical ingenuity admits of being made practical; 2d. From the confusion arising from the rapid advance in ordnance, steam engineering and ship construction; and 3d. From the variety of duties that a single man-of-war must be considered capable of discharging. Such difficulties will always arise until the subject of a new Navy is considered by a different body of men, and from a different standpoint.

*This paper was received too late to admit of discussion; but, as it expresses the opinion of a member of the present Advisory Board, its publication without discussion has been recommended by the Board of Control.—Editing Committee.

Happily, within the last four years a number of very troublesome topics pertaining to the Navy have been reasonably well settled.

1. It is generally conceded that, for all purposes, steel and composite-built ships are the best.

2. The Gun Foundry Board has made a definite report on the subject of guns.

3. The Fortification Board has made a definite report on the subject of coast-defense vessels heavily plated with steel. The types of these vessels have been carefully worked out by competent people, and also the types of some small coast-defense gunboats, and gun and torpedo boats.

This much, then, of the road is clear, and coast-defense vessels could be built *ad libitum* on plans already thought out, and no man could justly say that the money was ill-spent, for no country in the world is so defenseless as ours; but, in order that a definite policy of expenditure for a *sea*going Navy should be arrived at, a competent board is absolutely necessary. It is not a mere matter of choice whether we shall have a 3000-ton ship or full sail power, or two-thirds sail power, or no sail power, or a superstructure deck, or a poop and forecastle, or forty ironclads, or four ironclads, or turret ships or barbette ships, or dispatch boats or gunboats. These matters are important, it is true, but they are entirely secondary to, and many of them would be utterly wiped out by, the more important matters which affect the very existence of the seagoing Navy, and which should be thoroughly discussed by a competent board before the secondary matters are thought of.

All the boards that have been heretofore organized for recommending and designing ships have been either wrongly constituted, or else so hampered by the law creating them as to be worthless. These boards have been either composed of officers alone, or of officers and civilian experts. Both plans are wrong. Any board, to be efficient, should possess three qualities: 1st. It should not be too large (this was one trouble with the first Advisory Board); 2d. It should consist (with its president) of an odd number of members; 3d. It should be composed of men capable of discussing among themselves every subject that the duties of the board may give rise to.

Officers alone should not constitute a board: they are all (like myself) professionally anxious for a larger Navy than Congress and the country would deem necessary. Civilian shipbuilding and engineering experts are not necessary: there is better talent for *men-*

of-war-designing among our constructors and engineers in the Navy than can be found anywhere else in the United States. No civilian in the United States has ever built a modern man-of-war or its engine on his own design: these things cannot be originated or invented by anybody in a moment; and our officers have devoted more study to foreign plans than civilians have. The civilian element that *is* required on the board is that which is most readily found in Congress—men who by their habit of thought and national views are capable of studying the first and most important question which will come before this board—viz.: the political and geographical position of the United States with reference to the other nations of the world; its commerce, its future, and the corresponding seagoing Navy which is requisite. A second and most important duty of these members would be to so shape the final conclusions of the board that a sensible bill could be drawn up (based upon the report of the board to the President) for presentation to Congress, in which that body could find something tangible and definite to discuss. A third duty of these members would be to present this bill to both Houses of Congress and *defend it.*

This board should consist of a president and eight members, to be composed as follows: One member of the Senate Naval Committee of long standing, one member of the House Naval Committee of long standing, one Captain in the Navy, one Lieutenant-Commander or Lieutenant, one Naval Constructor, one Assistant Naval Constructor, one Chief Engineer, one Past-Assistant or Assistant Engineer. The president of the board to be the Secretary or Assistant Secretary of the Navy, and the secretary of the board to be an Assistant Naval Constructor. This arrangement would combine experience, practical knowledge and theoretical knowledge of all subjects which would come within the province of the board.

Should such a board be organized, the following results are quite possible:

The first duty would be to study, as I have indicated, the position of the United States and its commerce, present and future, in different parts of the world, together with the number of its citizens residing and in business abroad, and the amount of protection deemed necessary to be within easy call at any time. This would lead to a close study of the number of miles of coast that come within the jurisdiction of our several squadrons and the relative importance of our interests there; also to an estimate of the powers of offense and defense of the countries owning the territory. These considerations, together with

the peculiar conditions of each locality, its degree of civilization, belligerency, etc., would fix approximately the number of ships required; and to this number at least 25 per cent. must be added to provide for relief vessels going to and coming from home.

Having reached this approximation, the attention of the board would next be called to the number of men available to man these ships. We have but 8000 men in the Navy, and it would be a matter of serious consideration for the legislative members of the board whether it would be wise to go before Congress and advocate an increase of that number. This matter is seldom discussed, and yet it lies at the bottom of the whole fabric of a peace Navy. Of what use is it to advocate the building of 40 large ironclads, as some do, when a dozen of them would take all the men we have and not leave a man for anything else? I doubt, however, if any one in Congress would advocate a much greater number of men than 8000. Supposing that the number be limited to 8000, our naval coat must be cut according to this cloth, and, before utilizing it, there must be deducted the total number necessary at our numerous navy yards for taking care of laid-up coast-defense vessels and receiving ships, running tugs and steam launches, etc., etc. With the remainder, whatever it may be, an estimate must be made of the size of crews that can be allotted to the vessels for foreign service, the number of which has been previously approximately estimated.

In spite of all the labor saving appliances that ever have been invented, the crew of every man-of-war should be relatively large, to supply landing parties—a matter of growing importance in naval warfare. Hence, taking all these things into consideration, if the majority of this board were men of my way of thinking, the greater number of the vessels required by the United States in foreign waters would be small (from 400 to 1000 tons), in order to secure the greatest good by the greatest dispersion of our small total number of men. This dispersion is absolutely necessary to secure promptitude in affording that show of physical force at any point in a station which is so necessary to give confidence to the people requiring protection, and so essential to inspire respect among parties liable to give offense. It carries with it the necessity of having vessels in as many different ports as possible at the same time; that they should always be, so far as possible, within telegraphic communication with the admiral; that when changing stations the utmost expedition should be used from port to port; for a man-of-war out of telegraphic communication is useless in time of peace.

Allowing 100 men to each vessel, which is a very small number, it can readily be seen that in order to have seven or eight very small vessels actually on each of our stations, with their reliefs going and coming, we shall only have enough men left for seven or eight vessels carrying 300 men each, which would only give *one* of these vessels to a squadron. If this train of reasoning is correct, or only approximately correct, does it not at once simplify a great number of these minor questions of type, rig, etc., which are now so constantly thrust to the front?

If we can only have eight small vessels and one large one on the Pacific Coast, or in China, for example, can there be any question in this day but that the large one ought to be an ironclad? And, if the little ones cannot carry coal enough to steam across the Atlantic Ocean, is there any question but that they ought to have large sail power? This latter will diminish their steaming speed, to be sure, but not their general usefulness, and if the large vessel by not having sail power could carry seventy-five tons more coal or an inch more armor and make a knot more speed, ought she to be obliged to have it? And if the larger vessel, by reason of her excellent fighting qualities, has limited accommodations (as is sure to be the case), would it not be reasonable and economical to have a dispatch boat for a flagship?

It would appear that many of these other difficulties that we are now struggling with could be made to disappear by the same method of reasoning. By the system that I have adopted we do away with any discussion of relative merits, of Boston type or Chicago type, etc., etc., because we would have neither. If the board should decide that we wanted these types, and were willing to forego the obvious advantage of great dispersion of our small total of 8000 men, then the small classes of vessels would largely disappear and there would be no use in wasting breath in discussing *their* types.

Since the United States is eminently a nation of peace, its defenses should be made invulnerable, for its powers of offense will never be great, except possibly towards the end of a long war, if we should ever be so unfortunate as to become involved in one; therefore, the question of a seagoing Navy for a general war should be kept almost entirely separate from that of a peace Navy. Of course, such ships as are built at *any time* should have good guns and good engines; but the advance of modern science in every direction is so great, that it is simply impossible to construct a ship that might be able to meet all the contingencies of a war with a nation like England, for example.

No nation now-a-days, not even England, could protect its commerce in a great war, and it will probably have no occasion to do so after the first two weeks, as few steamers now-a-days are out from port longer than that, and no insurance could be obtained on cargoes under belligerent flags: ownership would be transferred to neutral flags at once; and, in any event, the very best commerce protector or commerce destroyer is a first-class merchant steamer bought out of hand, filled with Hotchkiss rapid-firing guns, and sent to sea full of coal.

General usefulness in *time of war*, for a man-of-war or any other vessel, is a question of coal-piles and not of canvas, and this question of coal-piles will be one of the most serious that our hypothetical board would have to consider; not that it would have any effect on the rig of our vessels, for no man-of-war would dare to go to sea in time of war under sail with any expectation of reaching port, let alone of capturing or protecting anything; but it would be the board's duty in its report to make the country alive to the importance of this vital point, and, if we are to have no coal-piles, to outline to Congress what our men-of-war must be almost obliged to do if they are away from home when a war breaks out and coal is still contraband of war —viz.: *Stay in port*, and in case of a long war dismantle ships and send crew and officers home.

Having fixed approximately the number and size of ships, the total cost could be estimated with a reasonable degree of precision, and an annual appropriation calculated which would finish all the ships at the end of a determined number of years; and in this way let Congress see what it has before it, in the same logical manner as has been done by the Gun Foundry Board and the Fortification Board.

As a conclusion, the board would be called upon to investigate how these ships are to be built and where, by contract or in the navy yards, or both; secondly, if all the navy yards are not to be employed, recommend what should be done with the unemployed ones; and lastly, if it is deemed wise that the unemployed yards be not abolished, make some suggestion in the direction of an appropriation for their maintenance which will be separate and distinct from the Navy Appropiation Bill proper, so that there may be a final ending of the continual reproach to the naval administration "that the Navy consumes annually fifteen millions of dollars and has not a ship to show for it." How can we have any ships when it takes fifteen millions for one gigantic organization merely to "mark time"?

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Charles E. Munroe.

The *Trans. Tech. Soc. of the Pacific Coast*, **2**, 267; 1885, contains a paper by Fred. H. Jenssen on "Dynamite Catastrophes," in which he criticises adversely the theory advanced by L. J. Le Conte† to account for their occurrence. Mr. Le Conte states that 90 per cent. of all the explosions on the Pacific Coast since 1879 occurred during violent desiccating north-wind storms, and that electricity has been the exciting cause in all these cases. Admitting the existence of a dry north wind at the time of the several explosions, it is a fact that the survivors of two of them give reasons for their occurrence which are at variance with Mr. Le Conte's theory.

The explosion at Stege on March 25, 1882, occurred during the manufacture of black powder, called Vulcan B. B. This powder is composed of sodium nitrate, sulphur and charcoal, which are mixed in a perfectly wet state. During this mixing process the superintendent called the foreman and told him that the mixture was not wet enough, and that he should put more water in the basin, as it had been demonstrated by experiment that where the mixture fell below a specified percentage of moisture it would ignite by the friction of the machinery. A few moments after the departure of the superintendent, and before the water was added, the explosion took place.

The explosion at the Giant Powder Works, January 21, 1883, was caused by sparks blown from a wheelbarrow of hot ashes into a box of dynamite.

As to Le Conte's second conclusion—that a dust explosion precedes

*As it is proposed to continue these Notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications, or trade circulars.

†Proc. Nav. Inst. **12**, 181; 1886.

that of the dynamite—Jenssen states that in the nitroglycerin department of the dynamite works there is no dust of an inflammable nature; nevertheless a number of explosions have taken place in that department, especially during the first years of the manufacture of dynamite, but now are of rare occurrence. In all the dynamite explosions named, with the single exception of that at the Hercules Powder Works, September 29, 1883, no explosion started in the mixing house, and not one of them can be traced to a dust explosion.

In regard to the danger from lightning, it is admitted that a stroke of lightning will explode dynamite, but small sparks of electricity will not do so. The Swiss committee on the physical qualities of dynamite reported,* some sixteen years ago, that "thunderstorms and lightning involve no special danger to dynamite. As far as conclusions can be drawn from small experiments with heavy discharges of electricity, dynamite, unless well confined, will only burn if struck by lightning. But if well confined, and if the temperature produced by the lightning be high enough, an explosion may possibly take place."

Apropos of the danger of nitroglycerin being exploded by the heat of the sun, the author asserts that *pure* neutralized nitroglycerin or dynamite will stand 170° F. for some time before it decomposes. Long experience has demonstrated that dynamite cartridges in boxes can sustain a temperature of 128° F. for years. But when the dynamite without covering has been exposed for a considerable length of time (varying with the quality) to the sun's rays, on touching it with blue litmus strips the paper turns red.

On January 29, 1881, a man by the name of Lasker was killed in McKean County, Pa., by the explosion of a lot of nitroglycerin which was being thawed by the agent of Roberts & Co. for the purpose of "shooting" an oil well. Suit was brought to recover damages for the loss of Lasker, and the official report of the trial, which was continued from court to court, and which contains considerable expert testimony, is recently come to hand under the title Roberts *vs.* Lasker, in the Supreme Court of Pennsylvania, Eastern District, Paper Book of Plaintiff in Error.

From this we learn that nitroglycerin was used in the liquid state in torpedoes for "shooting" oil wells. The nitroglycerin torpedo consists of a tin shell from three to five inches in diameter, and from five to

* Trauzl Nitrilverbindungen, Wien, 1870.

twenty feet in length, according to the quantity of glycerin which the well-owner desires exploded. All the shells are taken to the wells empty—the longer ones in sections, which are there put together as they are lowered into the well. The nitroglycerin is taken to the wells in square tin cans holding about six quarts each, and weighing when filled about twenty pounds each. This charge does not fill the cans completely, so water is poured in the space above to assist in the preservation of the nitroglycerin. After the tin shell is placed in the top of the well it is filled with nitroglycerin and tightly closed with a cover, in the middle of which is a percussion cap. When thus prepared the torpedo is lowered to the bottom of the well (a distance usually of about 1500 feet) by means of a wire. A perforated iron weight is then strung upon the wire, and, when the torpedo is properly placed, it is exploded by allowing the iron weight to drop from the surface of the ground and fall upon the cap.

The object of "shooting" the well is to remove the dense paraffins or other solids which obstruct the flow of the oil, and to shake the oil sandstone; and nitroglycerin has been found most efficient for this purpose. The right to use this explosive is, however, secured to Roberts & Co. by letters-patent, and has proved a most profitable monopoly, their profits at the time of the trial being fixed at three thousand dollars a day. Naturally their rights were infringed or evaded in many cases, and a class of men known as "moonlighters" sprung up in the oil regions, who exploded torpedoes in the oil wells at night. Others, however, simply placed a large torpedo in the well, and then employed Roberts & Co. to explode a small torpedo above it. The torpedo thus surreptitiously inserted in the well is known as a "setter," and it is believed by those who practise this that they successfully evade the Roberts patent.

As the driving of wells is carried on at all seasons, it frequently happens that the nitroglycerin comes on the ground in a frozen state. That was the state of the nitroglycerin in this case, and it was sought to thaw it by placing the cans (seven of them) in an oil barrel filled with water and passing steam through the water. Four of the cans were placed at the bottom, and the remaining three on top of these. The corks were out of the cans, so that the explosive was surrounded by water. The oil barrel rested on trodden-down snow, and the steam was brought seventy-five feet through a rubber hose stretched over the snow. There were fifty pounds' pressure in the boiler, and the throttle was turned about one-fourth. It seems undetermined

whether there was or was not an iron nozzle to the hose, but the end of the hose reached to within four inches of the bottom of the barrel. The hose remained in the barrel for about one-half hour, when it was taken out, as the water was thought warm enough. After another half hour it was put in again, and had been in but a short time when the agent walked to the barrel and found the water perfectly quiet, and so hot he could but just bear his hand in it (about 115°–120° F.). He then turned away, and had gone but about fifty feet, and had been away but about twenty seconds, when the explosion occurred. The agent was uninjured, but Lasker, who was in the engine-house, about six feet off, was killed. The defendant sought to show that a "setter" had been put in the well, and that the nitroglycerin for it had been thawed during the night in this same barrel, and that some of the liquid had been spilled in the barrel, but the court refused to admit the testimony. The plaintiff sought to show that the explosion was induced by the agitation set up in the barrel by the escaping steam, or by the energy developed by the steam impinging on the cans, but the real cause was left in doubt.

In the course of his testimony W. B. Roberts stated that he had made nitroglycerin since August, 1866, and that during that time he had made about one million pounds and handled one and a half million pounds. He first became acquainted with it after the explosion in Greenwich street, New York. The remainder of this had been buried by the authorities near Eighty-third street. Dr. Roberts went there, dug it up, and got about one hundred pounds, which he sent to Titusville, and used in the oil wells. The nitroglycerin now used is transported about the country, over the roughest roads, in spring wagons, the boxes being partitioned into squares the size of the cans, and upholstered with leather on the sides and bottom. The empty cans are destroyed by piling them on a brush heap, laying a train of nitroglycerin under it and setting fire to the whole. When explosion takes place at one point it is immediately communicated to the whole. No method of cleansing has yet been found which is effectual.

As giving some idea of the extent of the nitroglycerin industry in this country, we note that Mr. W. N. Hill stated in his testimony that, as chemist to the Repauno Chemical Company, he was, at the time (1882), making from fifty to one hundred thousand pounds of nitroglycerin a month. Sometimes he had made as many as ten runs, of six to seven hundred pounds each, at one time.

In the course of the trial various books were offered in evidence, and the court ruled that they might be read to the court to explain the scientific names and terms used, but not to the jury. The rule seemed to be that books written upon inductive sciences were not admissible, while those on the exact sciences could be offered. He believed the science of chemistry an exact science, and not an inductive one in a philosophical sense of the term, but the scientific knowledge of nitroglycerin might not be so exact as would authorize the reading of authorities in evidence to the jury. Some of these books might be evidence—for example, those which treated of the whole system of chemistry. He had grave doubts as to the articles written in the chemical journals being evidence, but they could be read to the court as law-books.

W. Poetsch (*Dingl. polyt. J.* **255,** 216) suggests "Recovering the Waste Acids from Nitroglycerol Works" by the following method: On heating the waste acids, consisting of sulphuric and nitric acids and organic nitro-compounds, at 105°, decomposition of the nitro-compounds ensues, oxidation to carbon dioxide taking place at the expense of the nitric acid which is present. During the reaction enough heat is liberated to volatilize the remaining portion of undecomposed nitric acid and the lower oxides of nitrogen produced, pure sulphuric acid being left in the residue. The author uses a closed vessel of stone or lead, having a perforated bottom 50 cm. above the bottom. The upper space is filled with stones or broken stoneware, and heated by hot air. The waste acid is introduced in a thin stream through a funnel fitted into the cover of the vessel, and, passing over the hot stones, is decomposed. The nitrogenous vapors are led through an earthenware pipe to a cooling worm, and collected in Wolff's bottles, air being introduced to oxidize the gases to nitric acid. The denitrated sulphuric acid flows through the perforated bottom, and is run into receiving tanks. (Abstr. *Jour. Chem. Soc.* May, 1885, p. 619.)

After more than seven years of investigation and experiment, the English royal commission appointed to inquire into accidents in mines has presented its final report, which was issued April 10, 1886, in the form of a blue-book of one hundred and ten pages. The delay is accounted for by the long and difficult quest on which the commissioners were sent. They were to report not only on the causes of

mining accidents, but also on the "possible means of preventing their recurrence, or limiting their disastrous consequences." Not much is recommended in the way of mere legislative changes, but the scientific recommendations are most interesting and important. For example: With reference to the difficult question of the best method of firing shots in mines, they state that "electrical exploding appliances present very important advantages from the point of view of safety over any kind of fuse which has to be ignited by the application of flame to its exposed extremity, as the firing of shots by their means is not only accomplished out of contact with air, but is also under most complete control up to the moment of firing. Their simplicity and certainty of action have been much increased of late years, while their cost has been greatly reduced, and but little instruction is now needed to ensure their efficient employment by persons of average intelligence. The use of electrical arrangements for firing shots in mines, where the employment of powder for blasting is inadmissible, should be encouraged as much as possible."

Again, they state that "it has been shown that mines which have hitherto been considered free from fire-damp may have the air which passes through them vitiated to an extent corresponding to about two per cent. of its volume of marsh gas. The air in many such mines may probably never be entirely free from explosive gas; at all events, in the neighborhood of freshly cut faces of coal and in the return air-ways. It has been demonstrated in our experiments that when the atmosphere contains five to five and one-half per cent. of marsh gas, it becomes highly explosive. We have even obtained explosions which, though less violent, might be, nevertheless, destructive of life if they occurred on the large scale possible in a mine, when the air contained only four per cent. of marsh gas. It will thus be seen that air which would appear free from gas if tested in the ordinary way, may become, by the addition of only about two per cent. of marsh gas, capable of propagating flame and causing destruction, while the addition of about three per cent. converts it into a highly explosive mixture. Air which would appear quite free from gas if examined by a lamp flame, may become explosive when laden with fine, dry coal-dust.* Appliances now exist by which very small proportions of marsh gas in air may be readily detected, and which can be used for examining the atmosphere of a mine. With Liveing's indicator, gas present in the air can be estimated with

* Proc. Nav. Inst. **8**, 308 and 459; 1882.

sufficient accuracy for all practical purposes, even when the proportion is as low as one-quarter per cent."

The suggestion, first due to Mr. Galloway, that coal dust alone suspended in air might cause an explosion, is considered, and an account is given of some carefully devised experiments which rather tend to confirm this conclusion. The commissioners discuss with some detail the means of removing this dust, and devote a large section of the report to the question of the conditions under which blasting can be done in safety. Considerable space is devoted to safety lamps, and it is pointed out how great an influence the velocity of the air-currents in the air-passages of a mine has on the safety of a lamp. The commissioners are of the opinion that the older Davy, Clauny, or even Stephenson lamps, have in a great measure lost their value in consequence of the draughts of air from the free ventilation. A current of air of eight hundred feet per minute in an impure atmosphere may, in spite of the wire gauze, effect an explosion in any one of them. The electric lamp is perhaps the chief hope of the miner, though it does not, like the safety lamp, indicate the presence of gas. A rigid daily inspection is recommended. (*Science*, **7**, 389, 459; 1886.)

A. Witz (*Compt. Rend.* **100**, 1131–1132; 1885) finds that the theoretical temperatures and pressures produced by the explosion of mixtures of coal gas and air, as calculated from the heat of combustion of coal gas, are as follows:

	At constant volume.		At constant pressure.	
	Temp.	Pres.	Temp.	Pres.
1 vol. of gas + 6 vols. of air.....	2064°	8.6 atmos.	1596°	6.8 atmos.
1 " " + 10 " "	1514°	6.5 "	1169°	5.3 "

Any difference between the calculated and observed pressures must be attributed to the action of the walls of the explosion vessel, since Mallard and Chatelier have shown that carbon dioxide and water do not dissociate below 1800° and 2500° respectively in explosions.

Although explosions of coal gas with air are by no means infrequent, the compiler has found considerable difficulty in producing them at will on a laboratory scale by simply mixing air and gas. Acting on these suggestions of the part played by dust, he has placed a small quantity of lycopodium in the stout glass cylinders

used for the experiments. Gas was then allowed to flow in, the vessel covered and shaken. Then on applying a flame there was invariably a smart explosion.

G. Schelgel, in treating of the "Combustion of Hydrocarbons and their Oxides and Chlorides with Mixtures of Chlorine and Oxygen" (*Annalen*, **226**, 133–174), says it has been shown by Bötsch (Abstr. 1882, 456) that in the explosion of a mixture of hydrogen, oxygen and chlorine, water is formed only when the chlorine is present in amount insufficient to unite with the whole of the hydrogen. This result is important, inasmuch as it does not agree with the generally accepted rule that when several substances react simultaneously on one another, those reactions always occur in which the greatest amount of heat is developed. The author has extended these researches to the products of the explosion of mixtures of chlorine and oxygen with gaseous organic compounds. Experiments were made with excess both of chlorine and oxygen, with an excess of oxygen and an amount of chlorine insufficient to unite with all the hydrogen present, and finally with an excess of chlorine, but with an amount of chlorine insufficient to convert the whole of the carbon into carbon dioxide. The organic substances employed were methane, ethane, propane, butane, methyl ether, methyl chloride, ethyl chloride, acetylene and carbon monoxide. No results could be obtained with ethylene, as it unites with chlorine in the dark, and so prevents the formation of a uniform mixture for explosion. The following are the conclusions drawn from these experiments: 1. If a hydrocarbon be mixed with excess of chlorine and excess of oxygen, and the mixture exploded by the spark, the whole of the carbon is converted into carbon dioxide, and all the hydrogen into hydrochloric acid. Hydrogen does not unite with oxygen, nor chlorine with carbon. 2. If excess of oxygen be employed together with an amount of chlorine insufficient to combine with all the hydrogen present, the remainder of the hydrogen unites with the oxygen. 3. If with excess of chlorine the amount of oxygen is insufficient to convert all the carbon into carbon dioxide, there is then also formed carbon monoxide, the proportion of this latter increasing with the deficiency of oxygen. 4. If neither chlorine nor oxygen is present in sufficient quantity for complete combustion, carbon is separated. 5. The organic chlorides and oxides experimented with behaved in like manner to the hydrocarbons. (Abstr. *Jour. Chem Soc.* March, 1885, p. 214.)

F. Bellamy has studied the "Action of Some Metals on Mixtures of Acetylene and Air" (*Compt. Rend.* **100**, 1460–1461; 1885), with the following results: When a spiral of platinum or silver wire, heated just to incipient redness, is brought into a mixture of acetylene and air issuing from a modified Bunsen burner made of glass, the gaseous mixture at once detonates and inflames, but the spiral does not become incandescent. If, however, a copper spiral is treated in the same way, the wire becomes brilliantly incandescent, and eventually ignites the gaseous mixture. A spiral of iron wire behaves in a similar manner, but the incandescence is more difficult to obtain; if the spiral is too hot the gaseous mixture is at once ignited; if too cold, the wire remains non-luminous. Copper or iron wire does not become incandescent in a mixture of air and hydrogen.

Colonel Samuel Wetherill, Jr., has privately communicated to us an account of an explosion of metallic zinc. While engaged in 1854 in the manufacture of this metal, he devised a plan for utilizing the "blue powder," which is the finely divided metallic zinc deposited in the prolongation of the condenser. The process consisted in swedging the powder into blocks and placing these blocks one above another in a furnace, where they melted down and were run into spelter. The workman in charge proposed to facilitate the process by feeding the "powder" directly into the hot furnace and ramming it down with a bar. On trying this the first shovelful exploded, and with such violence that the man was blown from the top of the furnace and the blade of the shovel driven into the roof of the building.

In this connection we may state that with the "blue powder" furnished us from the Bethlehem Works we have easily obtained Schwarz's explosive reaction* with sulphur, though we were unable to get it with the powdered zinc of commerce, owing probably to its being superficially corroded.

We are indebted to Sir Frederick Abel for a copy of his address on "Accidental Explosions Produced by Non-Explosive Liquids," which was delivered before the Royal Institution of Great Britain, March 13, 1883, and which deals with the explosions produced by the petroleum oils. The lecturer cites numerous instances of explosions from this cause which have occurred both on land and at sea,

*Proc. Nav. Inst. **9**, 750; 1883.

details the attending circumstances and seeks to explain the cause. The most interesting to us are those on the Coquimbo, Cockatrice, Triumph and Doterel, which the lecturer now believes to have been caused by the petroleum spirits used in the xerotine siccative.*

In the *Proc. Am. Asso. Ad. Science*, **33**, 130; 1885, Charles E. Munroe proposes to use an electric motor and gun-cotton for illustrating experimentally the "Conversion of Mechanical Energy into Heat." For this purpose a Griscom electric motor is clamped to the base of a retort stand with its axis of revolution vertical, while a brass disk to which a flat cork is cemented is clamped on the end of the shaft. A shallow cavity is made in the cork, the bottom of a test tube is placed in the cavity, and the tube clamped in place. Gun-cotton is now rammed into the tube, the vessel corked, and the motor set in motion. With four Grove cells the friction of the cork on the tube generates sufficient heat, in half a minute, to fire the gun-cotton and blow the cork from the tube. With this apparatus the difference in the points of ignition of gun-cotton and gunpowder, and of gunpowder grains of different sizes and densities, besides many other experiments depending upon the generation of heat through friction, may be easily and simply shown.

In the study of the "Action of Primary Alcoholic Iodides on Silver Fulminate," by G. Calmels (*Compt. Rend.* **99**, 794–797), 25 grams of dried silver fulminate were heated with 25 grams of methyl iodide and 40 grams of ether in a sealed tube at 50° for twenty-four hours. The products were silver iodide, methyl carbylamine and β-nitroethylene. Ethyl iodide and the higher primary iodoparaffins react in a precisely similar manner.

$$CNAg:CAgNO_2 + 2MeI = 2AgI + CNMe + CH_2:CH.NO_2.$$

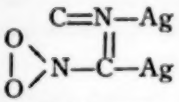
In this reaction silver fulminate is split up into two parts. In order, if possible, to obtain the intermediate compounds, $CNMe:CMeNO_2$, $CNEt:CEtNO_2$, 100 grams of methyl iodide mixed with 50 grams of ether were allowed to act on 50 grams of the dried fulminate at the ordinary temperature for four or five days, but the only products obtained were α-nitroethylene and methylcarbylamine. Ethyl iodide and its higher homologues behave in the same way.

The nitro-derivatives of the ethylene series are characterized by their power of existing in two modifications, the α-derivatives forming

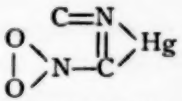
* Proc. Nav. Inst. 8, 313 and 459, and 671; 1882.

colorless liquids soluble in ether and chloroform, whilst the β-derivatives are yellow, resinous solids insoluble in the same solvents. From their chemical behavior, it would seem that the former are the true nitro-derivatives, whilst the latter are oximido-derivatives.

From these results it follows that silver fulminate contains two dissymmetrical groups, each of which contains one atom of silver. One of these groups is silver cyanide, CNAg, whilst the other contains the sub-group $N\begin{smallmatrix}O\\|\\O\end{smallmatrix}$ and the second atom of silver, the latter being united with the second atom of carbon, which is in direct union with the nitrogen in the first group (this nitrogen acting as a pentad), and thus links the two groups together.



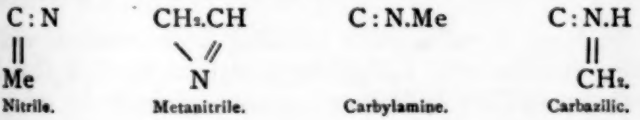
Silver fulminate.



Mercuric fulminate.

It is evident from this formula that the two metallic atoms in the silver fulminate have different functions, and this explains the non-existence of mixed fulminates of the alkali metals. The formula also explains generally the observed action of the halogens on the fulminates.

The fulminates are isocyanides or metallic carbylamines united by nitrogen to a bivalent residue of a metallic derivative of nitromethane, the metal attached to the nitro-group being any metal whatever. This function, which is peculiar to the carbylamines and does not appertain to the metallic nitriles (cyanides), may be termed the carbazilic function. The relation of the carbazilic type to the allied types is shown by the following formulas:—



Nitrile. Metanitrile. Carbylamine. Carbazilic.

In the study of "Mercury Fulminate," L. Scholvien finds (*J. pr. Chem.* **30**, 91–92; 1885) that a solution containing sodium fulminate is formed by treating mercury fulminate suspended in water with sodium amalgam. When this solution is decomposed with dilute sulphuric acid, and shaken up with ether, the ethereal solution is found to contain two acids of the composition HCNO. The less

soluble of these crystallizes from ether in colorless needles, melting at 85°; it is soluble in lukewarm water, but is decomposed by boiling water. It forms a red, insoluble silver salt, a dark yellow mercuric salt, and light yellow lead salt; its solutions yield a deep red coloration with ferric chloride. Decomposed by hydrochloric acid it yields hydroxylamine. The more soluble isomeride may be crystallized from hot water, yields no coloration with ferric chloride, and forms no insoluble metallic salts. The aqueous solution of sodium fulminate gives a precipitate of silver fulminate with silver nitrate, which when treated with metallic chlorides and aniline hydrochloride forms double salts. It is decomposed by ethyl iodide, and with potassium sulphide yields an easily explosive compound.

Mercury fulminate and thiocarbamide yield carbon monoxide, mercuric sulphide, carbamide, a compound thiocarbamide and mercuric thiocynate.

A. Ehrenberg states (*Jour. prak. Chem.* **30**, 38–68; 1884) that Carstanjen and he have shown (Abstr. *Jour. Chem. Soc.* 816, 1882) that when mercury fulminate is decomposed with aqueous hydrochloric acid it yields its nitrogen as hydroxylamine hydrochloride. A further examination of this reaction has proved that both carbon monoxide and carbon dioxide are formed. The quantity of these compounds produced is but small, more especially when the decomposition is effected in the absence of air; and it appears that they owe their origin to the decomposition of formic acid, which the author has shown is produced by the action of aqueous hydrochloric acid on mercury fulminate. The reaction taking place may be represented as follows:

$$C_2HgN_2O_2 + 2HCl + 4H_2O = 2H.COOH + 2NH_4.OH + HgCl_2.$$

In the hope of realizing the following decomposition, and thus obtaining fulminic acid, $C_2HgN_2O_2 + 2HCl = HgCl_2 + C_2H_2N_2O_2$, the author passed dry hydrochloric gas into perfectly dry ether containing mercury fulminate in suspension. Mercuric chloride is produced, and the ether holds in solution a compound which undergoes spontaneous decomposition, most probably fulminic acid. If this ethereal solution is carefully added to aqueous ammonia, and the ethereal solution separated from the aqueous solution, the latter contains a yellow solid, which is sparingly soluble in cold water, but soluble in hot water, from which it may be obtained in yellowish

needles. The analysis of this compound shows it to be $C_3H_4N_4O_3$. It forms with silver nitrate a compound ($C_3H_4N_4O_3$), $AgNO_3$, insoluble in cold water, and with an ammoniacal solution of copper oxide the compound $(C_3H_4N_4O_3)_2CuO(NH_3)_2$, which is obtained as a light-blue granular precipitate. From the ammoniacal solution from which the above compound was obtained the author has isolated an acid isomeric with fulminic acid, to which the name *isofulminuric acid* is given. It is easily soluble in water, from which it separates in ill-defined crystals; absolute alcohol dissolves it easily, and by cooling the hot saturated solution it is obtained as a white powder. With silver nitrate its aqueous solution gives a white amorphous precipitate of $C_3H_3N_3O_3Ag$, but yields no precipitate with ammoniacal solutions of copper oxide, lead acetate or mercuric chloride. The silver, ammonium and barium salts of this acid are described.

Together with this acid there is formed a small quantity of a compound more easily soluble in ether than isofulminuric acid, which is most probably the ammonium salt of amido-fulminuric acid, $C_3H(NH_2)N_3O_3.NH_4$.

Its aqueous solution gives precipitates with silver nitrate, lead acetate and copper sulphate, and a blood-red to brownish-red coloration with ferric chloride.

Thiocyanic acid reacts with mercury fulminate in a manner analogous to aqueous hydrochloric acid; mercuric thiocyanate, ammonium thiocyanate and carbon dioxide are produced, the production of the ammonium salts arising from the instability of hydroxylamine thiocyanate. The reaction may be represented thus:

$$C_2HgN_2O_2 + 4H.CNS + 2H_2O = 2CO_2 + Hg(CNS)_2 + 2NH_4.CNS.$$

The action of ammonium thiocyanate on mercury fulminate is analogous to the action of the chlorides of the alkali metals, but is more energetic; it may be expressed as follows:

$$2(C_2N_2O_2Hg) + 2H_2O + 2NH_4.CHS = C_3H_2N_3O_3.NH_4 + Hg(CNS)_2 + HgO + CO_2 + 2NH_3.$$

A. Ehrenberg (*J. pr. Chem.* [2], **82**, 230–234) obtains "Sodium Fulminate," $C_2N_2O_2Na_2 + 2H_2O$, by the action of sodium amalgam on an aqueous solution of mercury fulminate, the solution obtained being evaporated over lime and sulphuric acid. It crystallizes in colorless, lustrous prisms, which explode with great violence when rubbed; when left for some time over sulphuric acid and lime the

crystals become white and opaque, the anhydrous salt being formed. If the aqueous solution is evaporated on the water-bath, it turns yellow, and finally brownish-red. Similar changes occur on exposure to air. When an aqueous solution is electrolyzed, the products are ammonium carbonate and cyanate, a brown, humus-like substance, carbon monoxide, nitrogen and nitrogen monoxide, and towards the end of the decomposition carbon dioxide and small quantities of hydrogen cyanide. Hydrogen peroxide converts it into ammonia, sodium carbonate, carbon dioxide and hydrogen cyanide.

The *double salt* $C_2N_2O_2Na_2C_2N_2O_2Hg + 4H_2O$ is obtained by the action on mercury fulminate of half the amount of sodium amalgam necessary for its complete decomposition, or by mixing solutions of the two component salts. It crystallizes in colorless plates, is readily soluble in water, and is less explosive than the mercury salt. When a small quantity of dilute acid is added to an aqueous solution, mercury fulminate is precipitated. Strong hydrochloric acid decomposes it; mercury, sodium and ammonium chlorides, and hydroxylamine hydrochloride being obtained. (Abstr. *Jour. Chem. Soc.* 1191, Dec., 1885.)

T. Sandmeyer (*Berich. Berl. Chem. Ges.* **11**, 1767; 1885) finds that "Ethyl Hypochlorite" is formed when gaseous hypochlorous oxide is passed into alcohol, or when concentrated aqueous hypochlorous acid is mixed with alcohol. The most convenient method of preparation is to pass chlorine into an ice-cold solution of soda as long as it is absorbed, and immediately add, with agitation, one-tenth the volume of alcohol. The ether very soon separates, and after washing and drying with calcium chloride may be distilled. *Ethyl hypochlorite*, ClOEt, is a yellow, mobile, and very volatile liquid. It distils at 36° (under 752 mm. pressure undecomposed), but if the vapor be superheated a violent explosion occurs. Powdered copper (precipitated from copper sulphate with zinc), when added to the cold liquid, causes a similar violent explosion. Carbon and sulphur do not act upon the liquid. Ether, benzene and chloroform do not act rapidly on this ethereal salt, but its solutions in them appear to decompose gradually. When exposed to the direct rays of the sun it explodes violently, even when the vessel containing it is surrounded by iced water. In diffused daylight decomposition takes place more slowly, but the liquid becomes gradually warm, and after a time boils

violently, and leaves only a little acid liquid smelling of ethyl acetate. In its general properties it resembles hypochlorous oxide very closely, and acts on ammonia and many organic substances as a strong chlorinating and oxidizing agent. It immediately decomposes hydrobromic and hydriodic acids, liberating the halogens.

In the study of the "Nitro-Derivatives of Ethylene" A. Villiers (*Bull. Soc. Chim.* **48**, 422–424) obtained the compound $C_2K_2(NO_2)_4$ by the reduction of the potassium-derivative of tetranitroethylene bromide (Abstr., 1884, 33). This body undergoes decomposition after several days, forming a purplish-brown amorphous mass; potassium-hydrogen carbonate is also formed, and small quantities of an unstable substance soluble in water with an intense red color. By treating the compound $C_2K_2(NO_2)_4$ with chlorine, bromine or iodine in the presence of potash, tetranitroethylene chloride, bromide or iodide is formed. The aqueous solution of the potassium compound of tetranitroethylene bromide is slowly dissociated, an oily, colorless liquid being formed, which appears to be tetranitroethylene bromide. The *silver* compound $C_2(NO_2)_4Br_2Ag_2O$ crystallizes in brilliant yellow needles; it detonates at about 100°, and at 40° it is exploded on the slightest friction, although it cannot be exploded by friction at the ordinary temperature. It is blackened by the action of light. The *potassium* compound of tetranitroethylene chloride $C_2(NO_2)_4Cl_2KHO$ forms pale yellow crystals; it detonates at 147°. The corresponding iodine compound crystallizes in yellow plates, which alter rapidly and become black; it explodes at a higher temperature than the chlorine and bromine compounds, but causes a much more violent explosion. In the preparation of tetranitroethylene bromide (Abstr. 1882, 815) the flask is cooled by immersing it in cold water directly the action tends to become at all violent, and the operation is then conducted as usual; the formation of nitrous gas is almost entirely avoided, and much smaller quantities of other ethylene compounds are formed. The further reduction of tetranitroethylene bromide results in its complete decomposition into ammonia, and hydrogen cyanide and bromide. A small quantity of an alkaline compound was, however, obtained by treatment with ammonium sulphide; it contained potassium and sulphur, and formed a beautiful orange platinochloride. (Abstr. *Jour. Chem. Soc.* 1044, Oct., 1885.)

The following "Nitro-Derivatives of Furfurane" were studied by P. Priebs (*Ber.* **18**, 1362; 1885). *Nitroethenyl furfurane*,

$C_4H_3O.C_3H_3.NO_2$, is readily obtained by acting on furfuraldehyde in an alkaline solution with nitromethane. By treating this compound with nitric acid, *nitroethenylnitro-furfurane*, $NO_2.C_4H_2O.C_3H_2.NO_2$, is formed. When this is oxidized with chromic mixture it yields *nitro-pyromucic acid*, $NO_2.C_4H_2O.COOH$. This forms an insoluble silver salt which explodes on heating.

In referring to the statement that "Franklin,* in his Letters on Electricity (June 29, 1751), was the first to suggest the employment of frictional electricity for ignition of gunpowder," it may be interesting to note the following item from the *Maryland Gazette*, Annapolis, Md., June 14, 1749: "On Friday last (June 9), the gentleman who has exhibited the electrical experiments in town removed his machine off to the south side of our creek [Spa Creek?], and having set some spirits of wine in a small vessel on a table on the north side, he caused a spark of electrical fire to dart across in an instant through 200 yards of water, which set the spirits in a blaze the first attempt and several times afterwards, and discharged a battery ef eleven guns, to the surprise and great satisfaction of the spectators." The name of the exhibitor is not given, although an advertisement of his exhibition, together with a detailed list of his experiments, is repeated in several of the previous numbers.

* Proc. Nav. Inst., 11, 773; 1885.

PROFESSIONAL NOTES.

SUBMARINE BOATS.

By Mr. T. Nordenfelt.

[From *United Service Gazette.*]

The principal *raison d'être* of a submarine boat is the suddenness of its attack, and if the attack by torpedoes fired from a submarine boat is more effective than that fired from a surface boat, while the crew is less exposed in the submarine boat, it should find its place amongst the armaments of nations.

[Mr. Nordenfelt then enumerates the various submarine boats that have been invented since Bushnell's attempt to blow up the Eagle in 1776.]

The idea seems throughout to have been admitted that submarine boats, if successful, would become most valuable and comparatively inexpensive weapons for port defense; but none of the boats so far had given satisfaction, and I now beg to give my views as to the reason of their failure.

1. They were always built too small and too weak. The longest of previous submarine boats was 45 feet, or about half as long as my boats. Their small dimensions and weak plates made them useless in bad weather and dangerous for submersion, especially if touching the bottom or if coming in contact with any vessel.

2. They have never been made for firing a fish torpedo, consequently they have had to endeavor to fix a mine to the bottom of a vessel, which I consider impracticable, considering the risk of contact with the vessel, which, especially if pitching or moving, might easily destroy the boat. This also necessitates a complication of clock-work or electrical connections to enable the boat to get away, to avoid the fatal risk of being destroyed by the attacked vessel, as was the case with the boat which sank the Housatonic.

3. In all the early boats the mines were charged with only black powder, the effect of which was less destructive than that of the gun-cotton or dynamite in the fish torpedoes; and the effect of the explosion against a wooden ship was nothing like as serious as against the thin bottom plates of an ironclad.

4. All the boats hitherto in use have been propelled by hand power. This gave too much hard work to the crew, who could not take the boat any distance on the surface previous to the actual attack, and made it quite impossible to face any rough weather. In my boats, the use of steam diminishes the number of men, and they have so little to do when below the surface, that the temperature, which is anyhow lower than in modern stokeholes, is no detriment; the stokers, for instance, in my boats have nothing to do when the boats are submerged. My boats can go 150 miles and upwards, previous to the attack, without re-coaling.

5. All previous boats had most unreliable means of descending and ascending. The descent by steering downwards, in the American boats, twenty years ago, was quite as dangerous as the attempts before and after that time to lower and raise the boats, and to keep them steady at any desired depth, by means of increasing and decreasing the weight of the boats by more or less water-ballast, or by altering their displacement. None of those boats used the

principle which I have applied to pull the boat down by mechanical means, while relying upon its always-retained buoyancy for rising; so that if the mechanical apparatus fail, the boat rises at once to the surface. I consider it absolutely essential to keep the boat horizontal when moving, as any inclination downwards, with the impetus of a heavy boat, would almost to a certainty carry the boat below its safe depth before it could be effectually counteracted by shifting weights. The position, then, as regards torpedo warfare, seemed to me to be as follows: The submarine mines, placed at the bottom or floating anchored, had been adopted generally; but they were acknowledged not to fully satisfy the requirements for port defense, because they were immovable, and were exposed to be picked up by the enemy. The towed torpedoes of the "Harvey" class had not given satisfaction, and the spar torpedoes could only be used under very exceptional circumstances. The "Whitehead" and "Schwarzkopf" fish torpedoes were then the only ones that gave any hope of usefulness by future development. The fish torpedo is practically a projectile, and the torpedo boat may be called the gun which fires it; and the great expense in time of peace, added to the certainty to lose a number of these boats in war, made this means of discharging torpedoes exceedingly costly and unreliable. It seemed to me, therefore, of great importance to construct a means of carrying, with greater safety, the fish torpedoes up to such a short distance from the vessel to be attacked that the torpedo could not fail to hit. The surface torpedo boats at that date were met by machine guns, which made their attack in daytime almost impossible; and the improvements in the direction of greater speed and thicker protection of their vital parts have been met by greater power and longer range of the quick-firing machine guns, while their larger dimensions offer a target more easily hit. Thus, to-day, the surface torpedo boats really do not offer much greater certainty to reach striking distance than they did five years ago.

It seemed to me that a much greater chance would be given for carrying the Whitehead torpedo within striking distance if, instead of trying to rush the distance by many boats, all the time exposed to the destructive fire from machine guns, I could carry the torpedo secretly up to this distance without the probability of being seen at all, and without any probability of being struck by the enemy's shot, even if seen. This led me to take up the question of submarine boats; and I thought it best to build at once such a submarine boat as could not be suspected of being only an experimental boat, but one really useful in war.

The first boat I built at Stockholm, and which I had the honor to run at the experiments in Sweden last September, in the presence of delegates from most of the leading Governments. The following are its principal dimensions and details: Length, 64 feet; beam, 9 feet, but over sponsons 12 feet; draft, 11 feet; displacement, 60 tons; speed, on measured mile, 9 knots; distance travelled without re-coaling, 150 miles; depth to which it can safely descend, about 50 feet. Engines, surface-condensing compound type, with two cylinders and cranks at 90°, and, at pressure of 100 pounds to square inch, will indicate 100 horse-power. Boiler of ordinary marine return-tubes type, having one furnace and about 200 square feet of heating surface. Two hot-water cisterns, rhomboidal in body, with spherical ends. The boilers and cisterns contain about eight tons of water. Both boilers and cisterns are made for a working pressure of 150 pounds to the square inch. One fish torpedo, 14 feet, is carried outside on the bow, and discharged mechanically. The sinking apparatus consists of two vertical propellers driven by a 6 horse-power double-cylinder engine. These propellers are placed in sponsons on each side of the boat. One cold-water tank in centre of boat, holding about four tons of water for regulating buoyancy. This tank is used as coal bunker when doing long surface runs. Crew, three men. For longer distances, out of sight of the enemy, the boat runs on the surface, with the cupola and about three feet of its turtle back out of water, but by forced draft, blowing out its smoke under the surface.

When the boat arrives within such distance of the enemy that it might be discovered, it descends into the water so far that the cupola alone appears above water; this is done by taking in water into the cold-water tanks sufficient to reduce the floatability to what my horizontal screws are capable of overpowering; she runs thus "awash" until she arrives so near that even the small cupola might be discovered; then she descends altogether below the surface and advances up to striking distance entirely submerged, unless she requires to show the cupola above the surface once or twice for a few seconds to adjust her direction. The above-named reduced floatability is never done away with, but the descent from the "awash" position is effected by starting the horizontal screws, thus overcoming mechanically the buoyancy of the boat, which is pulled down to a less or greater depth, depending upon the speed given to the horizontal screws. As the density of water does not alter at varying depths, I can always count upon the exact amount of buoyancy being available for raising the boat to the surface whenever I stop the horizontal screws, or for lifting the boat nearer to the surface when I reduce the speed of the engines driving them. Thus, if any failure of these engines or propellers were to take place the boat would at once rise to the surface. In addition to my controlling the depth by varying the speed of the horizontal propellers, I have applied an apparatus for definitely regulating the depth at which I mean to move; this consists of a valve which controls the steam supply to the small engine; this valve being held open by a weight adjustable on a lever, the piston of the valve is also in direct communication with the sea, in such a manner that when I reach a depth at which the pressure in the sea is more than the pressure of the weight, the valve closes, the engines stop, and the buoyancy raises the boat until the outside pressure diminishes, when the weight again opens the valve. By this means I regulate exactly the depth at which I desire to move. When descending below the surface I carry altogether about eight tons of water, subject to the full pressure of steam, so that in case of more leakage than I can pump out of the boat by my steam pumps, I can at once counteract such leakage and rise to the surface by blowing out water. This must be much more reliable than to detach weights. On the surface I drive the boat by working the boiler in the usual manner, and I keep up the temperature of the water in the cisterns to a degree corresponding to a steam pressure of 150 pounds. When I wish to descend I close the ashpit and firedoor; then I close up the funnel inside boat and start the horizontal propellers. At this moment I thus have, as propelling power under water, the steam which will be given off by the heated water (about eight tons), and this has been found sufficient for a distance run of 14 knots, or more than is required for an attack in war. On that occasion we had still over 20 pounds pressure in the boiler when the boat was opened up. The boat is laterally very stiff, as I carry some six tons of lead in the bilge. Longitudinally the boat is balanced before starting by the arrangements of weights, and this can be adjusted by having more or less water in the two cisterns fore and aft. When descending the boat is perfectly horizontal, and is invariably kept so when moving under water by means of the bow rudders operated by a plumb weight. These bow rudders have been found to act so perfectly that there is actually no appreciable change from the horizontal position. Although the centre of gravity is well under the metacentre, the boat is so sensitive longitudinally that the bow rudders correct instantly any tendency to deviation from the horizontal position. Three men are sufficient crew for the boat, and I have proved that these men do not require any other air for sustenance in comfort than what the air space in the boat itself contains.

The dimensions of this first boat, as well as its speed and proportions, were settled especially for defense of coasts where there is an archipelago, as in Sweden, the west of Scotland, etc., and for the defense of ports with long estuaries—for instance, London, Liverpool, etc.—and I am still convinced that where handiness and small draft of water are important factors these propor-

tions cannot be much improved upon. The lines of my boats are drawn specially suitable for giving least resistance when the boats are submerged, consequently they are not so good when part of the boat is above water. The surface speed of my small boat being 9 knots, she is capable of even greater speed when submerged. Thus she can always, whether on the surface or below, do 4 to 5 knots against a 4-mile current. The question of what speed below water is most desirable must be found out by experience, and must depend upon the room and depth of water available, and upon how far greater speed, when submerged, may tend to detract from the secrecy of attack, and upon other questions which can only be determined by lengthened practice by intelligent officers, when fully trained to its use.

The three main points in my system of submarine boat to which I particularly wish to draw attention are: 1st. That by using water as the means of storing up energy, I am in possession of a reservoir which can never get out of order and which can be replaced at any hour in any part of the world, and without any extraneous assistance from shore or other ships. Whereas, if electricity were used, delicate and special apparatus would have to be employed as reservoirs of energy, such as accumulators or batteries, which if they should require repair or replacement would render the boat completely *hors de combat*, unless she were within reach of some electrical depot. Also, the durability of the cistern containing the water is immensely greater than of electrical apparatus, which—should a run of any distance be required—would still have to be provided with engines for the replenishing of their power. These objections also lie against the use of caustic soda or compressed air. Besides, after carefully investigating what could be done in other ways, I was fully convinced that I could by no other method store so much energy as by using heated water, especially as I have made it a point to design engines for my boats in such a manner that as long as I can have high pressure in my boiler I can use expansion; yet as the pressure falls in the boiler by reason of the steam being used when under water, I can regulate my engines so that they will work well down to and even below the atmospheric pressure. The reason of all others which at once decided me to adopt the hot-water system was the enormous factor of safety obtained by my being able to blow out by steam pressure, without the use of machinery, large weights of water, which would lighten the boat and counteract any leak likely to occur. Finally, I preferred to use the hot-water system because, the motive power being steam, ordinary marine engineers are at once familiar with it, and would have more confidence in the boat than if any new, delicate, or comparatively untried system were adopted.

2d. The submerging the boat by mechanical means. I feel confident that previous attempts have proved unsuccessful mainly because either they depended upon varying the displacement of the boat by taking in water to submerge her, and to regulate the depth at which they desired to operate, or they descended by steering downwards. My objection to the first-named method of descending by taking in water, and thus increasing the specific gravity of the boat, is that practically there is no difference in the specific gravity of water on the surface and at 50 feet depth; thus, when the boat has lost its buoyancy at the surface, it has also no buoyancy at any given depth, and the risk is thus very great of suddenly descending beyond a safe depth. Further, by this method they relied upon some mechanical means for ascending by ejecting water. In case such mechanical means failed, the boat would be lost. As regards the method of descending by steering downwards, I need only point out the great risk of allowing an object 100 feet long and of great weight to proceed in the downward direction even at a small angle, as the impetus gained would very easily carry it beyond safe depth so quickly that they might not have time to check it. On the other hand, by my system I rely upon no mechanical means for rising, but keep myself, by means of the speed of the horizontal propellers and the regulators, at any desired depth, with a sufficient force to keep steady when advancing at that depth; and as I never cause the

boat to leave the horizontal position, I am safe against the effect of impetus in a downward direction.

3d. The horizontal position I have found to be a *sine quâ non* for a submarine boat, and I have already above shown the great risk in allowing the boat to descend at an inclination. I have therefore provided rudders, which I prefer to place in the bow of the boat, and which by the action of a plumb weight are always held in the horizontal position, and therefore, should the boat from any cause tend to take a direction other than the horizontal, these rudders will immediately bring the boat back to the horizontal position. During experiments continued for a couple of years, I have found these rudders perfectly reliable, and they have never failed to effect their purpose. In addition to these three main features of my submarine boats, there are a few more points to which I wish to direct attention. There is really no trouble at all about the heat or the sufficiency of sound fresh air in the boats. The heat after the 14 miles' run above named was only 32° C. (90° F.), and after the first run at Landskrona, when the crew had been closed in from the outer air for three hours, the temperature was taken by two of the delegated officers at 31° C. (88° F.), while I am informed that in some monitors the stokehole temperature rises to 49° C. (120° F.), and I suppose it is not much cooler in some of the larger modern ironclads. As to the purity of air, there have been four men enclosed in the boat for six hours without any appreciable diminution in the length of flame of a tallow candle placed on the floor, the level where the air should be most impure.

I have not had the slightest difficulty in finding crews. My first engineer was one from the merchant service, my second one was engineer in the Swedish Navy, and my third one was again a civilian; any number of stokers have always offered their services, and many Swedish naval officers have urged me to let them command the boat. The risk to the crews ought to be very slight, and in war I consider that they would be safer in my boats than in many other positions. In case of accident the boat can always come to the surface, and the men can escape with life-belts. My compasses work in the same manner as in all other iron ships; that is, they do not work as satisfactorily as when raised far above the iron; but, as they work exactly the same whether the boat is on the surface or submerged, I can always take the bearing before descending and then be safely guided by the compass below. Lieutenant Hovgaard suggests that some electrical power should be carried in accumulators in addition to the steam power; this can, of course, be done if found useful; but I would prefer to avoid complication by carrying the weight of such accumulators in additional heated water. The main safety of the boat, of course, lies in the utter improbability of the enemy knowing that the boat is near, or that any attack is intended; next, it lies in the very short period of a few seconds in which the cupola appears above water, and which would generally not be long enough to enable the enemy's guns to ascertain the range. If the cupola is hit the boat is not disabled, as there is a cover which can at once be slung across the opening and make it water-tight, so that the boat can again descend out of sight, and go away to put on a spare cupola.

My boats are armed with one or two Whitehead torpedoes in tubes, and as soon as my controlled electrical torpedo is ready I propose to tow one of these as well. This torpedo will offer the advantage that steel-wire nets would be no protection against it, as the nets would be torn asunder or brought close to the ship's side by the impetus of the torpedo, weighing four tons, striking with a speed of fifteen miles an hour, so that its charge of 300 pounds of dynamite must explode as near to the ship as is required to make this heavy charge thoroughly effective.

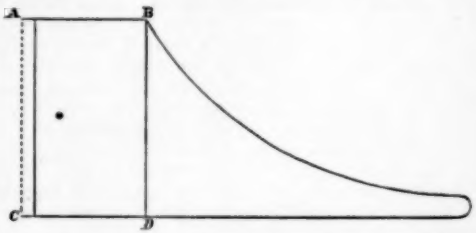
C. B.

CONDENSATION IN STEAM CYLINDERS.

[From *London Engineer*.]

No subject connected with the steam engine has received more attention than the condensation which takes place in the cylinder. Its theory is complete, and yet all the information possessed on the subject is strictly indirect, and no one knows at this moment precisely what takes place in a cylinder, nor will they know until experiments of an entirely novel character are undertaken and carried out by some competent authority. This ignorance manifests itself in various ways. The widest diversity of opinion, for example, exists concerning the utility of the steam jacket, about which there ought to be no uncertainty whatever if the accepted theory of condensation is really true; and extraordinary statements are made, by men of no mean authority, which it is almost impossible to prove or disprove. A very large quantity of water will find its way through an engine without making its presence felt by being stopped against the cylinder heads. If any engine ought to be free from condensation in the high-pressure cylinder, the triple-expansion engine would be that one. But experience has demonstrated that the high-pressure cylinder is always drowned with water, with the best boilers, and this with the jackets in full work. In a triple-expansion engine tested for this purpose last summer, it was found that whether the jackets were full of hot water or carefully blown down, there was no perceptible difference; and it was impossible to get a diagram free from the influence of water in the cylinder, and the indicator-cock always blew wet steam. The low-pressure cylinder, on the contrary, never betrayed the presence of water, and it was unjacketed. It is proposed here to consider the phenomena as they seem to exist, and to direct attention to the line which experiments should take.

The theory that steam condenses in a cylinder is based on very simple facts. 1. The presence of water is recognized by sight when an indicator-cock is opened, and by the continued dropping of water from high-pressure glands. 2. It is proved by direct experiment in the following way: In the accompanying diagram, the space *ABCD* represents the full-pressure part of the stroke.



The dotted line shows the clearance space. Suppose a cylinder 2000 square inches of piston area. It will be nearly 50½ inches diameter. Let the steam be cut off sharp when the piston has made 9½ inches stroke. Allowing ½ inch for clearance space, the cylinder and clearance will contain

$$10 \times 2000 = 20{,}000 \text{ cu. ins.} = 11.574 \text{ cu. ft.}$$

If the pressure is 100 lbs. absolute, 1 cu. foot will weigh .2307 lb. and 11.574 × .2307 = 2.67 lbs. = weight of steam per stroke accounted for by the indicator, and this result, multiplied by number of strokes per hour and divided by the indicated horse-power, will give the weight of steam used per hour per indicated horse-power. If now the quantity of water pumped into the boiler per hour is weighed, and this weight divided by the indicated horse-power, the

result will give, making an allowance of from 5 per cent. to 10 per cent. for insensible priming, the weight of steam supplied per hour per indicated horse-power by the boiler. In all cases, the latter figure exceeds the former; thus, the indicator showing, say, 13 lbs. per hour per horse-power, the weight of water pumped into the boiler may be 20 lbs. to 25 lbs. It is seen that the indicator accounts for 2.67 lbs. per stroke. The actual quantity of steam supplied by boiler may be 3.67 lbs.* What becomes of the difference? The answer is simply that it is mainly condensed by coming in contact with the cold cylinder, a small proportion being liquefied by the performance of work. This quantity is, however, so insignificant that it may be neglected.

It is very necessary that the bearings of this assumption should be fully comprehended. The usual mistake is to mix up all the cylinder condensing surfaces together—to regard, in a word, the whole cylinder as playing the part of a condenser. A little reflection will suffice to show that this is quite wrong. The boiler can only supply steam while the admission valve is open. The moment the cut-off closes, the cylinder is isolated from the boiler, and the steam does its work during expansion just as though the boiler never existed. During this the expansion part of the stroke, condensation may or may not take place. Whether it does or not, however, will not affect the weight of steam supplied to the engine, though it will affect the power developed, and therefore the weight of water used per horse-power. To prevent confusion, disregard the horse-power and deal only with what takes place per stroke. If no condensation took place, 2.67 lbs. would have sufficed under the conditions laid down. In point of fact, 3.67 lbs. are needed. Consequently, one pound of steam must be condensed at every stroke by surfaces of one head, one piston face and a belt 10 inches deep of the cylinder—or say, 5590 square inches, or in round numbers 39 square feet. The temperature of steam of 100 lbs. pressure is 328°. Thus one pound of steam can give up 883 units, or to each square foot about 22.6 units only. Thus it is clear that a small weight of iron will suffice to do all the condensing required, if only it is cold enough to begin. If its temperature has fallen to, say, 200°, then, the specific heat of iron being about one-ninth that of water, each nine pounds of iron would require 128 units to restore it to 328°, the temperature of the incoming steam. As there are only 883 units available, $\frac{883}{128} \times 9 = 62$ lbs. = weight of iron to be heated at each stroke. From which it appears that the temperature of the metal need not be affected to a greater depth than about $\frac{1}{25}$th of an inch to account for the condensation which takes place.

The figures and facts given are those commonly used to explain what goes on inside a cylinder. It is hard to dispute the accuracy of such reasoning, as regards single-cylinder engines; but the moment this line of argument is applied to compound or triple-expansion engines, difficulties arise. In the first place, the range of temperature will not be in the high-pressure cylinder more than about 47 degrees, instead of 128 degrees, and the steam in the jacket being at least as hot as that going into the cylinder, the cylinder walls should be maintained at so high a temperature that condensation in the cylinder is impossible. Under these circumstances it is difficult to explain why condensation takes place, and it is usually stated that none or next to none does occur; but facts entirely refute this, as much as 30 and 40 per cent. of the steam being reduced to water—as much being condensed as though the engine had but one cylinder; and so doubtful is the advantage of jacketing, that engineers neither know what cylinder to jacket nor whether it is worth while to jacket all or none.

But there are further puzzles to be solved. How is it, for example, that the

*It must be understood that 3.67 does not represent what will of necessity occur; the difference between the steam accounted for by the indicator, and actually supplied, is a very uncertain quantity, varying not only with different engines, but with the same engines under different conditions of load, speed and expansion.

low-pressure unjacketed cylinder, open at each stroke to the frigerific influence of the condenser, does not condense steam, but, on the contrary, re-evaporates the water carried to it from the intermediate cylinder? It is well known that while some 30 per cent. of all the steam made by the boiler may be condensed in the high-pressure cylinder before the cut-off valve closes, nearly the whole of this will be re-evaporated in the intermediate, and especially in the low-pressure cylinder. It may be taken as proved that a cylinder cannot evaporate more steam than it condenses, because all the heat available for re-evaporation during one stroke must have been imparted to the metal by steam during the preceding stroke. Yet the low-pressure cylinder is found actually acting like a boiler, taking in wet steam continually, and sending it away dry, or at least dryer than it was when it got it, the expansion curve often rising above the curve normal to the pressure and rate of expansion.

Further direct experiment is wanted to settle such problems as those cited. The thing to be ascertained is the actual rise and fall of temperature in the surface of the metal of a cylinder; the solution of this problem is attended with difficulties, but they are not insuperable.

It may be asked how it happens that the triple-expansion engine is so economical if condensation takes place in it to such a large extent. The answer to this question has already been given. Almost all the water resulting from condensation in the high-pressure cylinder is re-evaporated in the others, and the resulting steam being worked expansively, great economy ensues.

J. K. B.

BAIRD'S ANNUNCIATOR.

CHIEF ENGINEER'S OFFICE, U. S. NAVY YARD,
WASHINGTON, *December* 19, 1885.

Sir:—In compliance with instructions of the Bureau of Steam Engineering dated the 15th, and your order dated the 16th instant, the board appointed to examine the device described as "Baird's Annunciator" have examined the apparatus, observed its operation, and beg leave to report as follows:

The object of the device is to indicate upon deck, to the easy inspection of the officer in charge of the deck or his assistants, the direction of the movement of the engines, whether ahead or aback.

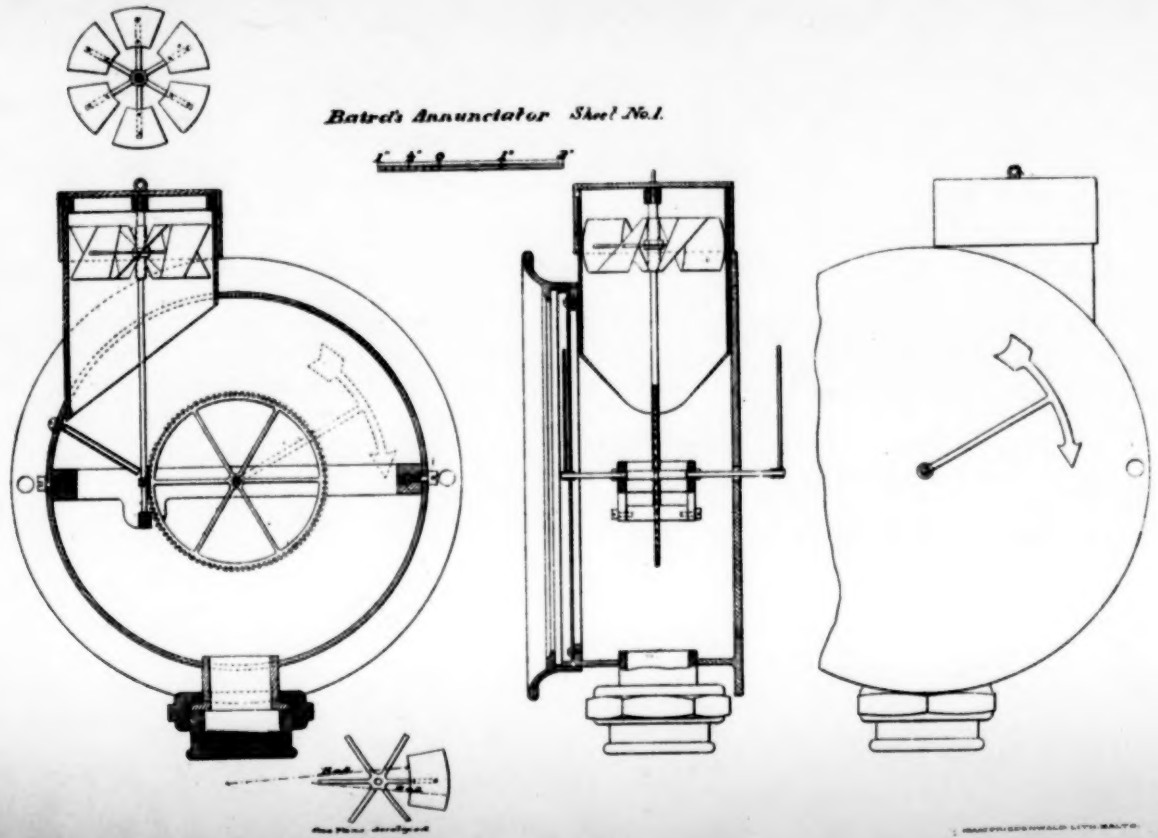
While the engines are working ahead an index revolves in the direction in which an arrow, on its free extremity, points; upon reversing the engines the motion of the index is reversed.

The mechanism immediately employed in producing these movements is enclosed in a case, of which the dial over which the index revolves is the face. The index is mounted upon a shaft or spindle, which carries a toothed wheel.

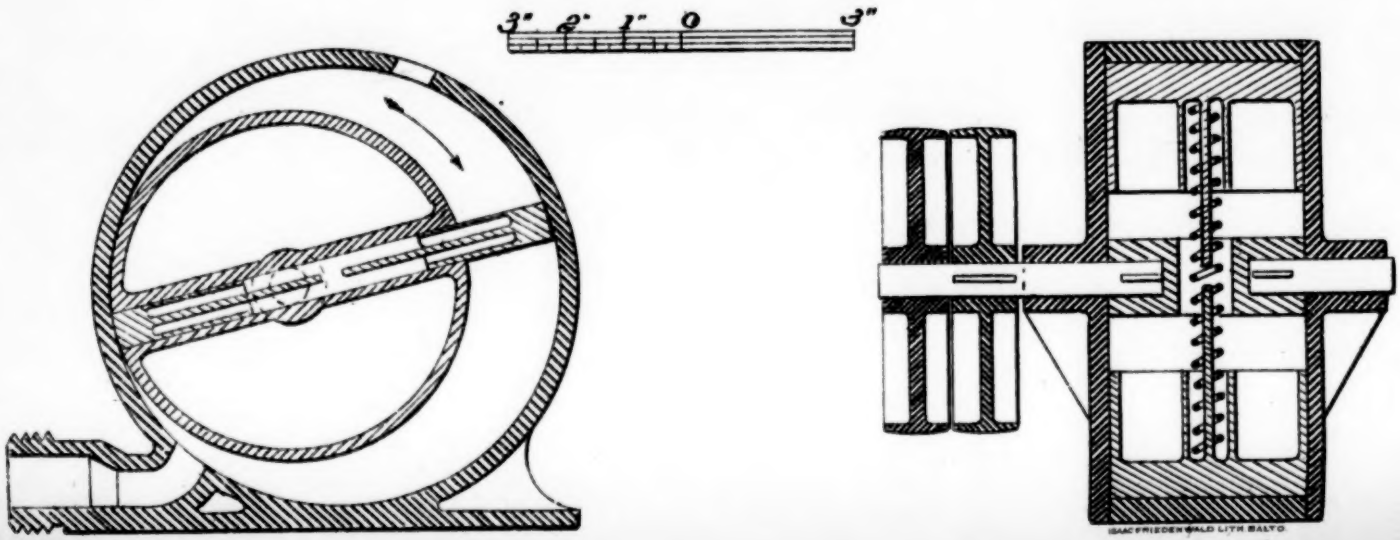
The wheel and spindle are turned by the revolutions of a second spindle placed at right angles with the first, carrying a worm or endless screw, the threads of which mesh with the teeth of the wheel. The second spindle carries also a series of fans, arranged like the blades of a screw propeller, or like the vanes of the common anemometer.

By means of an air-current, which flows in one direction when the ship's engines are going ahead, and in the opposite direction when they are backing, the fans and their spindle are rapidly revolved, and the proper motion transmitted through the spiral gearing to the index. The movement of the index is moderate in speed, but the speed is variable with the speed of the engine, and incidentally affords a means of estimating, by the eye, the speed as well as the direction of the movement of the engines and the ship.

The air-current is derived from a small rotary blower placed near the engine


Batrel's Annunciator Sheet No.1.

Baird's Annunciator. Sheet No. 2.



shaft, and turned by it through the operation of belts. When turned in one direction, the blower draws the air from the vanes of the annunciator through a pipe, in one enlarged extremity of which, forming a mouth, the vanes revolve. When turned in the opposite direction, the air is driven through the connecting pipe to the vanes, and the direction of the movement of the latter upon the instant reversed.

It is a very great advantage to the person manœuvring the ship to know, without the delay attending inquiry, or observation of the movement of the ship herself, exactly what the latter is to be. Should mistake be made, it will be apparent before it is too late to correct it.

The apparatus is simple and elegant, the power consumed by it is inconsiderable, and it is not at all likely to get out of order.

Its first cost needs never to be great, and the cost of maintenance is trifling. Drawings of it are hereto appended.

The board recommends it for purchase and use for purposes under cognizance of the Bureau of Steam Engineering.

We are, sir, very respectfully, your obedient servants,

CHARLES H. BAKER,
Chief Engineer, U. S. N.

R. D. TAYLOR,
P. Asst. Engineer, U. S. N.

R. R. LEITCH,
P. Asst. Engineer, U. S. N.

COMMODORE W. W. QUEEN, U. S. N.,
Commandant.

U. S. NAVY YARD, WASHINGTON, COMMANDANT'S OFFICE,
December 24, 1885.

Respectfully referred to the Bureau of Steam Engineering.

W. W. QUEEN,
Commodore, Commandant.

CLOSED FIRE-ROOMS.

From an abstract of a paper recently read before the Institute of Naval Architects by Mr. Richard Sennett, the following data on forced combustion have been obtained. The object of the paper was to supplement the information obtained from the trials of the Satellite and Conqueror by details of the trials of H. M. S. Rodney, Howe, Mersey and Scout.

The proportions of the boilers and engines of the Rodney are such as to give with natural draught about 8000 indicated horse-power. With forced draught on a four hours' trial, the mean indicated horse-power developed was 11,158, with an air-pressure of 1.4 inches of water. On the forced-draught trial of the Howe, a sister ship of the Rodney, the mean indicated horse-power developed was 11,728. The proportions of the boilers and engines of the Mersey would under natural draught give about 4000 indicated horse-power, while under forced draught the trials gave a mean of 6628 indicated horse-power, with an air-pressure in the fire-room equivalent to 2 inches of water.

Mr. Sennett states that, from the experience the Admiralty have now gained respecting the steam-generating powers of boilers in closed fire-rooms kept under moderate pressure, and the well-known economical employment of steam in triple-expansion engines, they are satisfied that on the full-power trials of these vessels at least 20 indicated horse-power per square foot of grate, and between 23 and 24 indicated horse-power per ton of boiler, will be realized, and this condition has been readily accepted by the engine contractors. The

maximum limit of the air-pressure allowed on the Admiralty trials was equal to 2 inches of water. This pressure, with further experience, will probably be made higher, with a corresponding increase in the steaming powers of the boilers. The closed fire-room system tends to promote economy of fuel, in consequence of the better supply of air and the higher temperature at which the fires are worked. J. K. B.

TABLE I.—ABSTRACT OF STEAM TRIALS.

	Open Fire-Room.			Forced Draught.				
	Inflexible.	Colossus.	Phaeton.	Mersey.	Scout.	Rodney.		Howe.	Caroline.
Date of trial	Nov. 14, 1878.	Jan. 10, 1884.	Feb. 12, 1884.	Sep. 24, 1885.	Sep. 23, 1885.	June 13, 1885.	June 16, 1885.	Jan. 14, 1886.	Mar. 4, 1885.
Duration of trial in hours	6	5	5	3	4	4	3	4	6
Number boilers used	12	10	8	6	4	12	9	12	2
Mean pressure in boilers, pounds	61.06	61.52	85.35	107.8	113.09	93.06	92.74	89.21	84.52
Mean air-pressure in fire-room in inches of water	....	....	....	2.02	1.52	1.4	1.89	2.05	1.5
Mean pressure in cylinders { High pressure	29.55	40.66	43.56	56.53	61.42	59.02	49.73	59.51	43.9
Mean pressure in cylinders { Low pressure	9.83	12.09	11.43	22.82	24.31	12.8	12.1	13.43	12.79
Mean revolutions per min	73.26	89.96	100.26	122.34	152.33	103.42	100 13	106.63	77.8
Mean speed of piston, feet per min.	586	585	802	795	762	776	751	800	389
Indicated horse-power	8483	7492	5588	6628	3370	11158	9544	11725	983
Area fire-grate used, square feet	829	645	546	399	207	756	567	756	545
I. H. P. per square foot of grate	10.21	11.62	10.23	16.61	16.28	14.75	16.83	15.51	18.02
Heating surface per I. H. P. in sq. feet { Tubes	2.20	1.97	2.23	1.56	1.63	1.54	1.35	1.46	1.24
Heating surface per I. H. P. in sq. feet { Total	2.63	2.33	2.61	1.77	1.83	1.82	1.6	1.73	1.43
Coal used per I. H. P. per hour, pounds	2.06	2.55	2.39	2.48	2.6	2.2	....	2.16	2.54
Coal used per hour in tons	7.80	8.53	5.96	7.33	3.92	11	....	11.39	11.11
Remarks	Blast used last half hour only.	Blast used throughout the trial.	Natural draught only.						

NOTE.—The I. H. P. recorded is that developed by the main engines only, and does not include the I. H. P. expended in working the feed and circulating pumps, and other auxiliary machinery.

TABLE II.

	1. Ship.	2. Date.	3. Load on safety-valve.	4. I. H. P.	5. Weight of boilers.	6. Area of fire-grate.	7. I. H. P. Per sq. feet of fire-grate.	8. I. H. P. Per ton of boiler.
			Pounds.		Tons.			
Open fire-room.	Inflexible	1878	60	8483	756	829	10.21	11.22
	Colossus	1883	64	7492	594	645	11.62	12.61
	Phaeton	1884	90	5588	462	546	10.23	12.1
Forced draught.	Howe	1885	90	11,725	632	756	15.54	18.5
	Rodney	1885	90	9544	474	567	16.83	20.1
	Mersey	1885	110	6628	306	399	16.61	21.7
	Scout	1886	120	3370	174	207	16.28	19.3
	Trafalgar (estimated)	....	135	12,000	514	609	20.00	23.3

NOTE.—The weight of boiler given includes weight of water, funnel, uptakes, fittings, spare gear, etc.

DETERMINATION OF CURRENTS BY A SERIES OF FOUR ALTITUDES.

From the French of J. Réveille, Professor of Hydrography.

I.

If at sea three simultaneous star altitudes are observed, the three corresponding lines should cut, which point is the true position of the ship. In general this will not be, and the three lines will form a triangle, due to a personal error, measured by the radius of the circle inscribed in the error triangle, or sometimes the radius of one of the inscribed circles.

In what follows we shall suppose the personal error eliminated.

II.

The ship's position can be determined by a series of altitudes taken at different moments, called interval altitudes. In fact, without much error, we can suppose the ship carries with her, parallel to themselves, her lines of altitude, which are geometrical lines of her position, converging to the real point. Suppose four interval altitudes have been taken, referred to the fourth horizon and corrected for personal error; they should pass through one point. Generally this does not happen, for if the observations are repeated in the same whereabouts, systematic errors quickly are seen, which are attributed to current action.

Mr. Fasci, Professor of Hydrography, remarks that the direction of the cur-

rent is obtained by tracing the line cut by the altitude lines into segments proportional to the time intervals separating the observations.

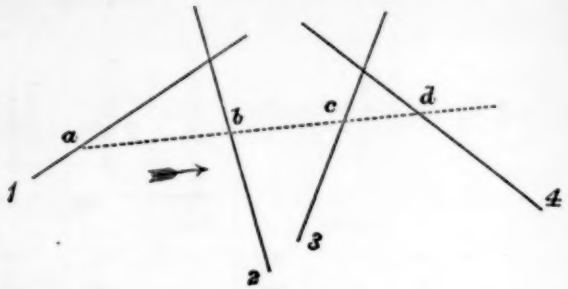


FIG. 1.

Let 1, 2, 3, 4 be four altitude lines referred to the fourth horizon; let a, b, c, d be the direction of the current, and let d be the ship's position.

The line 3 should have cut 4 at d; hence the ship has moved by current from c to d, similarly from b to c, and from a to b. Assuming the strength of the current constant, the distances passed over are proportional to the time intervals; hence the line $abcd$ can be traced, cut by 1, 2, 3, 4, as given.

Mr. Fasci gives a practical solution of this problem. The solution to be given may not be more practical nor simpler, but its examination leads to geometrical considerations that give renewed interest to the question.

III.

1. Let 1, 2, 3, 4 be the four altitude lines; $abcd$ the line sought; the segments ab, bc, cd are proportional to the numbers m, n, p, and we have

$$\frac{ab}{m}=\frac{bc}{n}=\frac{cd}{p}.$$

All lines cut into segments by 1, 2, 3 proportional to m and n touch a certain curve that is their envelope; the same for all lines cut by 2, 3, 4 into segments proportional to n and p. The line sought will be a common tangent to these two curves.

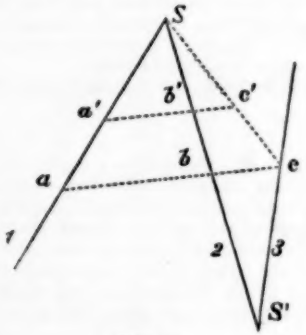


FIG. 2.

Draw separately the lines 1, 2, 3 (Fig. 2). Draw any line $a'b'$ that cuts 1 and 2 at $a'b'$ and take on this line a point c', so that $\frac{a'b'}{m} = \frac{b'c'}{n}$. Join this point to S, the intersection of 1 and 2; Sc' will cut 3 at c. Draw through this point a line parallel to $a'b'$; this will be cut by 1, 2, 3 in the relation of $\frac{m}{n}$; it will be a tangent to the curve envelope drawn parallel to the direction $a'b'$.

As the line Sc' meets 3 only at one point, but one tangent ab parallel to $a'b'$ can be drawn. Hence:

The curve envelope sought is such that but one tangent can be drawn to it parallel to a given direction.

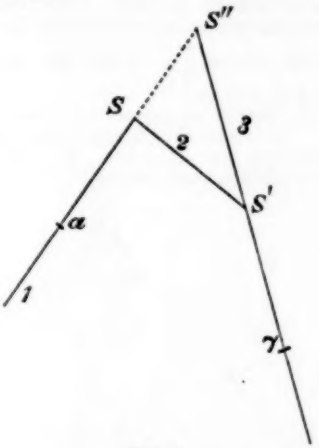


FIG. 3.

2. It is easy to see that the lines 1, 2, 3 are tangents to the curve envelope. Prolong 1 (Fig. 3) until it meets 3 at S'', and take a point a on 1 such that $\frac{aS}{m} = \frac{SS''}{n}$. It is evident that if we wish to draw through the point a line divided by 1, 2, 3 in the relation of $\frac{m}{n}$, 1 fulfils the conditions. This line, therefore, is tangent to the curve envelope, and a is the point of contact. In the same manner it can be shown that 2 and 3 are also tangents, of which the points of contact divide SS' and $S'S''$ (noting signs) in the relation of $\frac{m}{n}$.

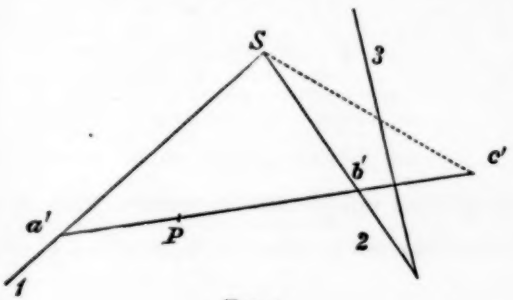


FIG. 4.

3. Let a line $a'b'$ pass in any direction through any point P (Fig. 4). Upon this line select a point c' so that $\frac{a'b'}{m} = \frac{b'c'}{n}$.

To each line $Pa'b'$ a point c' corresponds; all these points form a curve whose intersections with 2 give the points c that must be joined with P to have the lines passing through P, and divided by 1, 2, 3 according to the required conditions. Where is c? Join Sc'; to each line $Pa'b'$ but one point c' corresponds, consequently but one line Sc'. Inversely to each line Sc' but one line Pc' corresponds, as but one line can be drawn through a point cutting the three converging lines (1, 2, Sc') and fulfilling the given conditions. Thus, it follows that the lines Sc' and Pc' correspond homographically, and the locus of the points c' is a conic passing through S and P. This conic cuts 3 in two places; there are, therefore, two points c, consequently two lines Pc passing through P, divided by 1, 2, 3 in the relation $\frac{m}{n}$. These two lines are two tangents of the curve envelope; and as two can be made to pass through any point, it follows that the curve envelope is of the second class, of the second degree, and is a conic section. We have seen already that but one tangent can be drawn parallel to a given direction; therefore, this conic section is a parabola. The envelope sought is a parabola tangent to the three lines 1, 2, 3 at α, β, γ (Fig. 5).

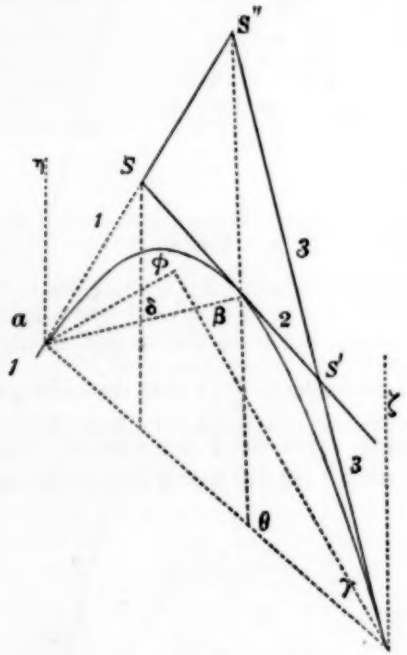


FIG. 5.

4. As the focus of this parabola will be needed in what follows, we shall determine it.

If δ, the middle of the cord of contact $\alpha\beta$, be joined to S, it will give $S\delta$, the

direction of the parabola's axis. The tangent of a parabola bisects the angle formed by the direction of the axis and the radius vector.

We shall have, then, the radius vector $a\phi$ of the point a by forming with Sa the angle $Sa\phi$, equal to ηaS; also the radius vector of γ by drawing $\gamma\zeta$ parallel to the axis and by drawing $\gamma\phi$, making with $S''\gamma$ the angle $S''\gamma\phi$ equal to $S''\gamma\zeta$. Their intersection is the focus of the parabola.

5. Similar demonstration will show that the envelope of the lines divided by 2, 3, 4 into parts proportional to n and p is a parabola tangent to 2, 3, 4, and its focus ϕ' can be determined. Hence, this admitted, it will be sufficient to draw a tangent common to these two parabolas.

Two conics have, in general, four tangents in common. For the parabolas under consideration three of these tangents are known. These are the line at infinity, and the lines 2 and 3; but one remains to be found, and the problem has but one solution.

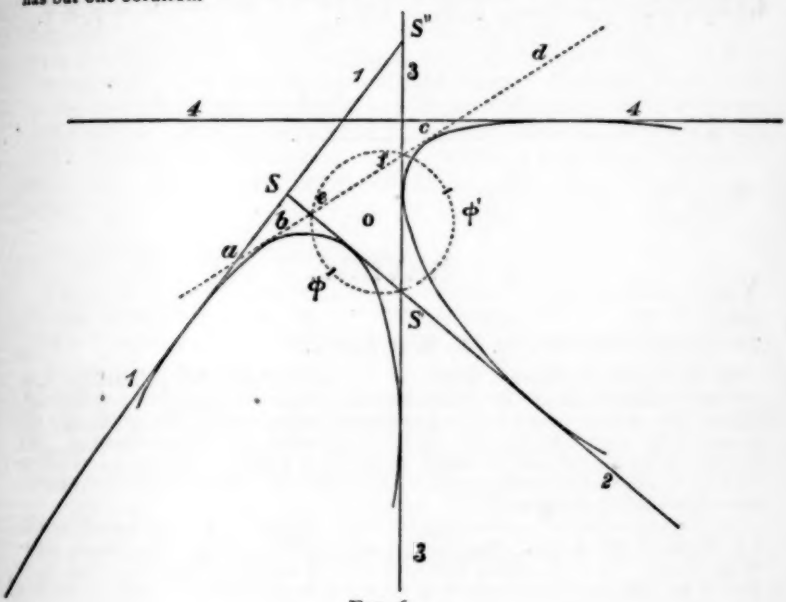


FIG. 6.

Suppose this fourth tangent ef drawn (Fig. 6). The triangle efS' is circumscribed to each of the two parabolas, and the circle circumscribed about this triangle will pass through the foci ϕ and ϕ' of the two parabolas, according to a property to be shown later. Hence this circle o passes through three known points—S', ϕ and ϕ'. We take, then, the intersections ef of this circle with the lines 2 and 3; the line ef will be the common tangent sought, or, as seen above, the line that divided under the required conditions by 1, 2, 3, 4 indicates the direction of the current.

The speed of current can be found by dividing any part of $abcd$ by the corresponding time interval.

The following is the property of the parabola referred to: The circumscribed circle of a triangle, itself circumscribed to a parabola, passes through the focus of the parabola.

The following demonstration we think to be new; it is based upon the consideration of imaginaries in geometry: Poucelet has shown that if a polygon exists at the same time inscribed in a conic C, and circumscribed to a conic C', an infinite number exist. This accepted, let us consider a parabola, and a circle passing through its focus ϕ; let us call I and J the circular points at infinity; these are two imaginary conjugate points. The triangle ϕIJ is inscribed at the circumference, for any circumference of the plane passes through the circular points, and, besides, it passes through the point ϕ. This triangle is circumscribed to the parabola, for the side IJ, which is the line at infinity, is tangent to any parabola of the plane; further, it is known that ϕI and ϕJ are the tangents drawn from the focus of the parabola. The triangle ϕIJ, therefore, is at the same time inscribed in the circle and circumscribed to the parabola. Then, according to Poucelet's theorem, if a circle is made to pass through the focus of a parabola and the two angles of the circumscribed triangle, it will pass through the third angle. E. B. B.

REVIEW.

THE LOSS OF THE OREGON. By R. B. Forbes.

An interesting brochure in which the veteran navigator has collated the most trustworthy accounts of the disaster to the Oregon that have been published. The author makes some valuable professional suggestions, and emphasizes the necessity for more boat and raft capacity for saving life in such disasters. He states that whenever possible there should be a hawser run from the vessel in distress to the rescuing one, to expedite the transfer of passengers, and he cites many interesting examples.

In this connection he advocates that every ship should carry a small mortar for throwing out a line. He strongly advises that mattresses, pillows, state-room doors and deck seats, should be fitted as life preservers; that there should be arrangements for shutting off steam from the deck in case the firemen are driven up from below; that the boilers should be emptied to make use of their floating power, amounting to several hundred tons; and that ocean steamers should travel in well-defined lanes.

His suggestions are well sustained by reasoning and examples, of which his great experience is prolific. J. W. D.

BIBLIOGRAPHIC NOTES.

AMERICAN INSTITUTE OF MINING ENGINEERS, TRANSACTIONS PITTSBURGH MEETING, FEBRUARY, 1886.

Theories accounting for the recent failure of steel boiler plates in England. Notes on the constitution of cast iron. Proposed apparatus for determining the heating power of different fuels. A new method of laying submarine tunnels and tubes. Peculiar phenomena in the heating of open-hearth and Bessemer steel. Soft steel for boiler plates. The Clapp-Griffith converter. The mineral resources of the Hudson Bay Territories. Miti's castings from wrought iron or steel. The specific gravity of low-carbon steel. The Heine safety boiler. J. K. B.

ANNALEN DER HYDROGRAPHIE.

PART II. Tidal and current observations on the east coast of Africa. Port Hamilton—Notes by the commander of the Nautilus. Caleta Buena in Chili. Meteorological and hydrographic notes.

PART III. Researches of Prof. E. Loomis on the form and motions of cyclones. Notes by the commanders of several German cruisers. Meteorological and hydrographic notes.

PART IV. The sun as the cause of variations in the earth's magnetism and in the Northern Light. The Marshall Islands. Nautical, hydrographic and meteorological observations. Cruise of the Nautilus on the south coast of Corea. Porto Plaza on St. Iago. Temperature coefficients in testing chronometers. Meteorological and hydrographic notes. J. T. S.

BULLETIN DE LA RÉUNION DES OFFICIERS.

MARCH 13, 1886. Repeating arms.

There is no longer any question as to the efficacy of repeating arms; they have been adopted and are being gradually supplied to the European armies. Austria has in use the Mannlicher, a positive-motion gun, the magazine containing 5 cartridges, fired at the rate of 30 a minute. France is experimenting with the Gras-Kropatchek and the Gras-Lee. Germany is substituting a gun which is said to weigh five pounds less than its predecessor. The paper then describes the Hébler gun. C. B.

FRANKLIN INSTITUTE JOURNAL.

MARCH, 1886. The development of dynamic electricity, by Wm. D. Marks.

APRIL. Tornado study, by Lieutenant J. P. Finley. Construction of a large proxy brake, Prof. R. H. Thurston. Summary of engineering and industrial progress for the year 1885, by Dr. Wm. H. Wahl. Report of committee on Delany's system of multiplex telegraphy.

MAY. The blast furnace, by John M. Hartman. Hydrographic work of the United States Navy, by Lieutenant A. B. Wyckoff, U. S. N. The law of cylinder condensation in steam engines, by L. d'Auria.

JUNE. Experiments made at New York Navy Yard to ascertain the economic effect of using in a non-condensing engine saturated steam alone, and of using it mixed with compressed hot air, by Chief Engineer Isherwood, U. S. N.

These experiments were made by a Board of Naval Engineers, with an apparatus submitted by Mr. E. M. Strange, for the purpose of ascertaining how much economic gain, if any, attended the use in a non-condensing cylinder of a mixture of saturated steam and of air compressed to the pressure of the steam and containing its heat of compression. The opening for the passage of the compressed air was in the steam pipe below the throttle valve. The results of the trial showed neither gain nor loss in economy of fuel due to the use of combined air and steam, comparably with the use of steam alone.

To the question: How could any other result be expected? Mr. Isherwood states in substance that the condensation of steam is greatly lessened by the admixture of air with it, as is shown upon a large scale in the atmosphere, which holds aqueous vapor in a state of gas at temperatures enormously below the liquefaction point of the vapor when not mixed with air. Professor Osborne Reynolds has also proved by direct experiment that by mixing air with the steam before it was used, the condensation at the surface of a cylinder may be greatly diminished, and consequently the efficiency of the engine increased. The use of air, however, in connection with steam will not produce any economic effect, unless the two are intimately mixed; merely delivering them in masses avails nothing. There is, of course, great difficulty in producing any such thorough mixture. Time for such mixing is utterly wanting during the operations of a steam engine.

In the experiment with Mr. Strange's apparatus the steam and the air were delivered into the cylinder in distinct masses, separately and successively. There was no time for natural mixing, and no provision had been made for artificial mixing by means of appropriate mechanism; consequently no saving in fuel was produced; but this want of economic effect was not due to any unsoundness or error in the principle or theory, but solely to the fact that the principle was not applied under the conditions requisite for success. And here will be found the explanation of many similar failures in which the practical results were a most disappointing outcome from unquestionably sound premises.

The Oram system of marine propulsion.

The Oram system of propulsion is designed to procure higher speed in steamships, with an increased carrying capacity, and to avoid some of the risks of accident incident to propulsion by stern screws. It consists of an improved form and construction of hull, in which provision is made for a novel location and operation of screw propellers in cavities or recesses on both sides of the vessel.

The propellers are located about one-fifth of the length of the vessel abaft the bow. The cavities in which they are placed are so shaped as to guide the water to and from the propellers with the least possible friction and resistance.

The propellers are susceptible of rotating independently; they are attached directly to the shafts of the engines, on angles of divergence which cause a downward, outward and rearward discharge of the water, attended with a corresponding reaction propelling the vessel.

The advantages claimed for the system are: a saving in weight and cost of machinery; the long shaft and alley to contain it are avoided and the space made available for storage, a degree of elasticity and flexibility in hull construction becomes admissible, which in stern-screw propellers could not be tolerated.

Experiments on the transmission of power by gearing, by Mr. Wilfred Lewis. J. K. B.

JOURNAL DU MATELOT.

No. 12, 1886. By a decree of the Minister of Marine, diverging torpedoes will no longer be used by French ships, and all torpedoes of that type are to be turned into store upon the arrival of a ship at a naval station.

No. 18. The P. & O. S. S. Carthage recently went through the Suez Canal by night, and from the testimony of six of the oldest pilots who were on board, the passage by night is as easy as by day. The passage was made by means of electric lights on board the ship, one ahead, one on each side, and one astern (the latter being used only in the entrances and in the curves), and of ordinary kerosene oil lights on the banks of the Canal.

The electric-light apparatus, including engine and dynamo, is movable, and is taken on board at the entrance and put ashore at the other end; it belongs to the P. & O. Co., and is reserved for the use of their steamers. C. B.

MECHANICAL ENGINEER.

MAY 29, 1886. U. S. S. Puritan.

A history and description of the Puritan, with full-page illustrations of the engines.

Relative strength of hollow and solid-wrought shafts. Instructions for treatment of mild steel ship-plates. Heating feed-water at sea.

MITTHEILUNGEN A. D. GEBIETE D. SEEWESENS.

VOL. XIV., NO. 1. Retrospect of maritime law and legislation, 1884 and 1885. Artillery of the United States. Ericsson's submarine cannon. Trials of torpedo boats for the English Navy. The Russian Navy. French Navy. Torpedo boats for Chinese waters.

Nos. 2 and 3. Tactics of torpedo boats (trans.). Retrospect of maritime law and legislation, 1884 and 1885 (end). Magnetic observations, by Professor Gelcich. Illuminants for lighthouses. Notes on torpedo boats of the English, French and Spanish Navies. New vessels for the French Navy. Budget of the Russian Navy for 1886. The yachts Puritan and Genesta. Cruise of the Austrian corvette Hilgoland on the west coast of Africa in the years 1884 and 1885.

This volume contains much important information, commercial and otherwise, in reference to most of the West African ports, as well as to the Canary and Cape de Verde Islands. J. T. S.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIP-BUILDERS.

VOL. II., 1885. On the application of hydraulic pressure to the driving of machines, by Mr. R. H. Tweddell. On the construction and fittings of salvage steamers, by Mr. Otto Ullstrom. On the stiffening of collision bulkheads, by Mr. M. C. James. Forced draught, by Jas. Pattison and Magnus Sandison. J. K. B.

PROCEEDINGS OF THE SOCIÉTÉ DES INGÉNIEURS CIVILS.

OCTOBER, 1885. Trials of a steam engine constructed on the Quéruel system.

Floating dock at Rotterdam.

Built of iron, in two parts, each forming a distinct and separate dock complete in itself; one 90 m., the other 48 m. long. Exclusive of their own weight, the larger dock can raise 4000 tons, and the smaller dock about 2000 tons. Both docks can be emptied in two hours.

NOVEMBER, 1885. The use of dynamite in large mining operations. Mutual forces and their application to mechanical, physical, and chemical phenomena. Marine exhibit of Belgium, France, England, Holland, Italy and Germany, at the Antwerp International Exposition. Outlines of an international language proposed by Mr. Maldant. Remarks by Mr. Kerckhoffs in favor of "Volapük."

DECEMBER, 1885. Employment of dynamite for the blowing up of large mines (plate). Experiments with indicators on locomotives.

Cannon tubes of Martin steel unhammered.

Composed of first-choice material, cast iron, waste forged iron, and a little ferromanganese containing silicon, treated by the Martin process. The steel obtained is absolutely without bubbles; it is reheated and allowed to cool in powdered coal: this rectifies the interior tensions and imparts high elasticity and resistance. Breaking strain 61 kilog. (134 pounds), with increase of length of 13 per cent.; elastic limit 22 kilog. (48.4 pounds), and diminution of section of rupture 14.4 per cent.

Cannons of 8.4 cm. (3.3 inches) thus manufactured have endured 2000 fires with service charges without injury or enlargement of the powder chamber.

E. B. B.

RIVISTA DI ARTIGLERIA E GENIO.

DECEMBER, 1885. A mountain howitzer carriage. Rifle practice. The Spezia experiments of October, 1884.

JANUARY, 1886. A summary of contents for the years 1884, 1885. The Flood Rock explosion. Gen. Thayer's system of aërial navigation.

FEBRUARY, 1886. Translation of No. 31 of the Naval Institute Proceedings (Report of the Gun Foundry Board). Italian military balloons.

MARCH, 1886. Translation of No. 31 Naval Institute, continued. Formulae for indirect fire. R. C. S.

RIVISTA MARITTIMA.

DECEMBER, 1885. Hydrographic work by the Vettore Pisani: Patagonia, Chili, the Galapagos and Philippine Islands, 1882–1885. The battle of Ecnomus. The Italian Navy estimates.

MARCH, 1886. Navigation notes from the cruise of the Vettore Pisani, continued. Italian Navy estimates. Report of the Fortifications Board, translated. R. C. S.

REVUE MARITIME ET COLONIALE.

MARCH, 1886. The ports of Tonquin. Cyclone off Cape Horn. Central administration (Navy Department) of the Navy and of the Colonies. Liquid fuel. Stockless anchor. The lighting of lighthouses by electricity.

APRIL, 1886. Report of Lieutenant Le Roy of the passage from Brest to Toulon of Torpedo Boat No. 61. Finished or projected works upon the English Channel and North Sea harbors, and the influence they may exert upon the coast.

Hurricane in the Gulf of Aden, June, 1885.

Exceptional, owing to its terrific violence; the few instances known of a similar tempest in the Gulf; the fact of its course being from east to west; the diminution of its diameter as it advanced up the Gulf, contrary to all previous observations; and the total failure of the barometer to announce its coming.

The tides of the Charente. Atlantic currents.

Copper spheres, barrels and bottles, with suitable inscriptions in several languages, sealed up in glass phials, were put over at regular intervals from the Prince of Monaco's yacht Hirondelle, upon a line 170 miles long, running about north 14° west. Ten spheres, 20 barrels, and 149 bottles were put over. Two bottles, 1 barrel, and 2 spheres have been recovered. Although nothing conclusive has been established, the drift of the recovered objects tends to show that no water from the southward of 42° N. reaches the coast of France; going to prove the object of the investigation—that the climate of the French Atlantic Coast is not influenced by the Gulf Stream.

MAY, 1886. Historical studies on the French Navy. Determination of currents by four altitudes taken at intervals.

Japanese cruiser Unébi.

Launched April 6th, at Havre. Built by Mr. Marmiesse. Length between perpendiculars, 321 ft. 3 in. (98 m.); draught (mean), 18 ft. 9.3 in. (5.72 m.); displacement, 3700 tons. Armored deck extending the whole length of the vessel. Divided above the armored deck into 57 compartments, separated by cofferdams formed of bulkheads, 17.71 in. (45 cm.) apart, and filled in with cork; the cofferdams also are divided into 40 compartments. Hull entirely of steel. Armament, 4 9.44-in. (24 c.) Krupp guns in half turrets, 170° train, 6 5.9-in. (15c.) Krupp in broadside and of the same calibre as a chase gun, all mounted on central-pivot Vavasseur-Canet carriages, built at Havre. In addition 2 6-lb. and rapid-firing Nordenfelts, 10 Nordenfelt mitrailleuses (4 barrels 25 mm.), and four Gatlings (new model), and four torpedo-discharging tubes. Ammunition giving 110 fires for the larger guns, and 4000 for the smaller. Estimated speed 17½ knots. Twin screws, each worked by independent engines; total horse-power 6000, with ordinary capacity to steam 5600 miles at

10 knots; by the addition of 200 tons, which can be done easily, she can steam at this speed 8000 miles. Barque-rigged. Fitted with a steam capstan capable of working all four chains, and two hoisting windlasses for ordinary deck work. Below the armored deck she is divided into 29 compartments. Crew 280 men.

Notes and observations by Lieut. M. E. Perrin, French Navy.

New Italian torpedo boats.

There are 24 of various types actually constructing, raising the number to 83.

E. B. B.

UNITED SERVICE GAZETTE.

FEBRUARY 13, 1886.

Admiral Aube, the French Minister of Marine, has decided to detach the torpedo service in each French port from the other branches of the harbor defense, and to place it under the supreme command of either a captain or a lieutenant in the Navy, according to the importance of the place.

FEBRUARY 20.

The Italian Admiralty have provided for the construction of twenty-eight torpedo boats of different types, all of which are to be built in Italy.

The Anson, a twin-screw armor-plated barbette ship, was launched February 17th, at Pembroke. The principal dimensions are: Length between perpendiculars, 330 feet; extreme breadth, 68½ feet; displacement, 10,000 tons; engines, 9500 H. P., and indicated speed, 16 knots. The belted armor will be 18 inches thick; she will carry four 64-ton guns, six 6-in. broadsides, 10 Nordenfelts, and 12 quick-firing guns; her complement of officers and men is 430.

FEBRUARY 27.

According to the *Marine Zeitung*, of Vienna, the German fleet at present consists of 13 ironclads, 14 armored gunboats, 9 armored frigates, 11 cruising corvettes, 5 unarmored cruisers, 4 unarmored gunboats, 8 dispatch vessels, 11 harbor-defense vessels, and 10 pilot ships; in all, 97 vessels, with 558 guns, 180,117 tons, 163,005 I. H. P., and 16,682 men.

MARCH 13.

The French Minister of Marine has recently tested the navigability of torpedo boats and their action in discharging their projectiles. The boats were sent from Cherbourg around by Gibraltar to Toulon. While their sea-going qualities in bad weather are excellent, the vibration, want of fresh air and lack of comfort are such that the crews cannot endure more than thirty-six hours of continuous navigation, when they must have rest or be relieved. On the other hand, the projectiles worked admirably. While the Admiral Duperré was steaming in fine weather at a speed of 14 knots, two stationary boats discharged six torpedoes at different angles, and all struck and exploded. The Duperré, steaming 14½ knots, was again struck twice by torpedoes from boats going in the opposite direction at a speed of 9 and 12 knots, the discharges being made at a distance of about 500 yards. From observation on board the Duperré, it was found that the projectiles were totally unaffected by the wash of the ship.

APRIL 3.

According to the *Marine Zeitung*, the torpedo organization of the German service is, in order to render it more efficient, to be placed under the charge of a "Torpedo Inspection," with headquarters at Kiel. The Inspector-in-Chief will decide on all matters connected with the construction and equipment of the boats, training of their crews, laying of submarine mines, and the general torpedo defense of harbors. He will, however, have no authority over boats attached to a squadron.

APRIL 17.

On March 24th, an obsolete armored vessel, the Armide, was towed to sea in the Juan Gulf and allowed to drift as a target for the French Mediterranean squadron, which fired at her while steaming at ranges of 3000, 4000 and 5000 metres, with 24, 27 and 32 cm. guns. In time the hull resembled a colander, and the vessel would have sunk had she not been filled with casks.

The Spanish Government has contracted for two first-class Yarrow torpedo boats of the Falke type, to have a speed of 23 knots fully equipped and 25 knots an hour light.

There are now 1173 guns in course of construction for the English Navy, 557 being for armored, 109 for protected, and 507 for unprotected. Of this total there are 5 110-ton and 18 66-ton; the rest are of smaller calibre, among which are 182 5-ton guns, 177 6-pounder Nordenfelt and Hotchkiss, 264 3-pounder Hotchkiss, 97 1-inch 4-barrel, 151 1-inch 2-barrel, 62 0.45-inch 5-barrel Nordenfelts, and 56 0.45-inch 5 and 2-barrel Gardners.

The Amphion.*

She has two 2-barrel Gardners in maintop and in the mizzen, and one Nordenfelt in the foretop. Under the forecastle and poop are two 4-barrel 1-inch Nordenfelts; there are two torpedo tubes on each of the lower decks. A fieldpiece is mounted on the poop, and it is intended to supply two 5-barrel Nordenfelts for tops and boats. The gun trials proved satisfactory. The ship, however, did not show much stability; in going about she rolled considerably and heeled 17°.

Regulations for training leading stokers and stokers in the use of arms and in the management of the machinery and boilers of torpedo boats.

The English Admiralty have issued a series of instructions in regard to the engineer force, in which it is provided that all stokers are to receive instruction in rifle, cutlass and pistol drill; second-class stokers not to be rated stokers without a fair knowledge of these drills; stokers to be trained in working of torpedo-boat boilers and machinery, and when qualified in this and in drills to be rated trained men and to receive 1d. a day extra pay; trained men to receive extra pay when on regular torpedo duty. The instructions also provide in details for the torpedo-boat exercises and for the qualification of the trained men.

MAY 1.

A new fast cruiser is to be built in Kiel to replace the German wooden corvette Ariadne. She is to be built on the cellular system, to have an armored deck, and to make 18 knots. Another similar vessel, the Elisabeth, is now building at Stettin.

At the trial of the Haytian gunboat *Toussaint l'Ouverture*, built at Havre, 13½ knots speed was attained; she is to carry two 12-cm. guns, arranged to deliver a fore and aft fire, and 16-cm. gun forward.

The Grasshopper, the first of a newly designed class of steel gun and torpedo vessels, is building at Sheerness. She will be 200 feet long, 23 feet beam, 6 feet 6 inches draught forward, and 9 feet 6 inches aft, and will have a speed of 19 knots in a rough sea. The armament is to consist of B. L. R., Gardner and Nordenfelt guns, and four torpedo tubes.

MAY 8. "Another gun burst."

On the 4th instant, a 43-ton gun burst on board the Collingwood, fortunately without injury to any one. The vessel left Portsmouth in the morning to try

*Nav. Inst. Proc. **11**, 830.

the Vavasseur mountings of her after pair of 43-ton guns. Six rounds were to be fired from each, two with reduced charges of 221¼ pounds of cocoa powder, and four with full charges of 295 pounds. The projectile was a common shell weighing 714 pounds, filled with water. A scaling charge of 73¾ pounds was first fired from each gun to clear the rifling of any possible obstruction. The right gun was then fired with the reduced charge of 221¾ pounds; upon firing the left gun with the same charge it exploded, the separation occurring at the forward rim of the B_3 coil.

The smoke of the explosion had so completely stained the face of the fracture that it was impossible, on a cursory survey, to observe any flaws or defects in the manufacture. The cleavage was exceedingly jagged, some of the rents showing that the core at the spot had been torn away from the hoop as from a socket. About six inches from the point of fracture, the outer coil itself had been riven entirely round. This circular rent was about one inch in diameter, and extended through the jacket to the steel core of the gun, appearing as if the weld of the coil had been torn open at the moment of separation. The damage to the ship was considerable. Some of the fragments ploughed up the deck; the armored top and grate of the neighboring scuttle were smashed, the ladder to the barbette gallery was torn away, and the glacis plates deeply indented. The hinges of the armored door of the bulkhead were fractured; the shelter screen at the flying deck was bulged in and penetrated; the adjoining Gardner machine gun was broken and dismounted, and the face of the reflector was completely splintered. The entire muzzle of the gun, which was unprotected by sheet coiling, was blown away, leaving a deep fissure between the cylinder and the last coil. C. B.